

APPENDIX N

Conceptual Wetland Mitigation Plan

Conceptual Wetland Mitigation Proposal

Cordova Hills Project

Sacramento County, California

I have reviewed this document and approved its submittal to the appropriate agencies.

Signature

Date

Prepared For:

Cordova Hills, LLC.

31 October 2014



Conceptual Wetland Mitigation Proposal

Cordova Hills Project

Sacramento County, California

USACE # SPK-2004-00116

USFWS #TBD

Prepared For:

Cordova Hills, LLC.

31 October 2014

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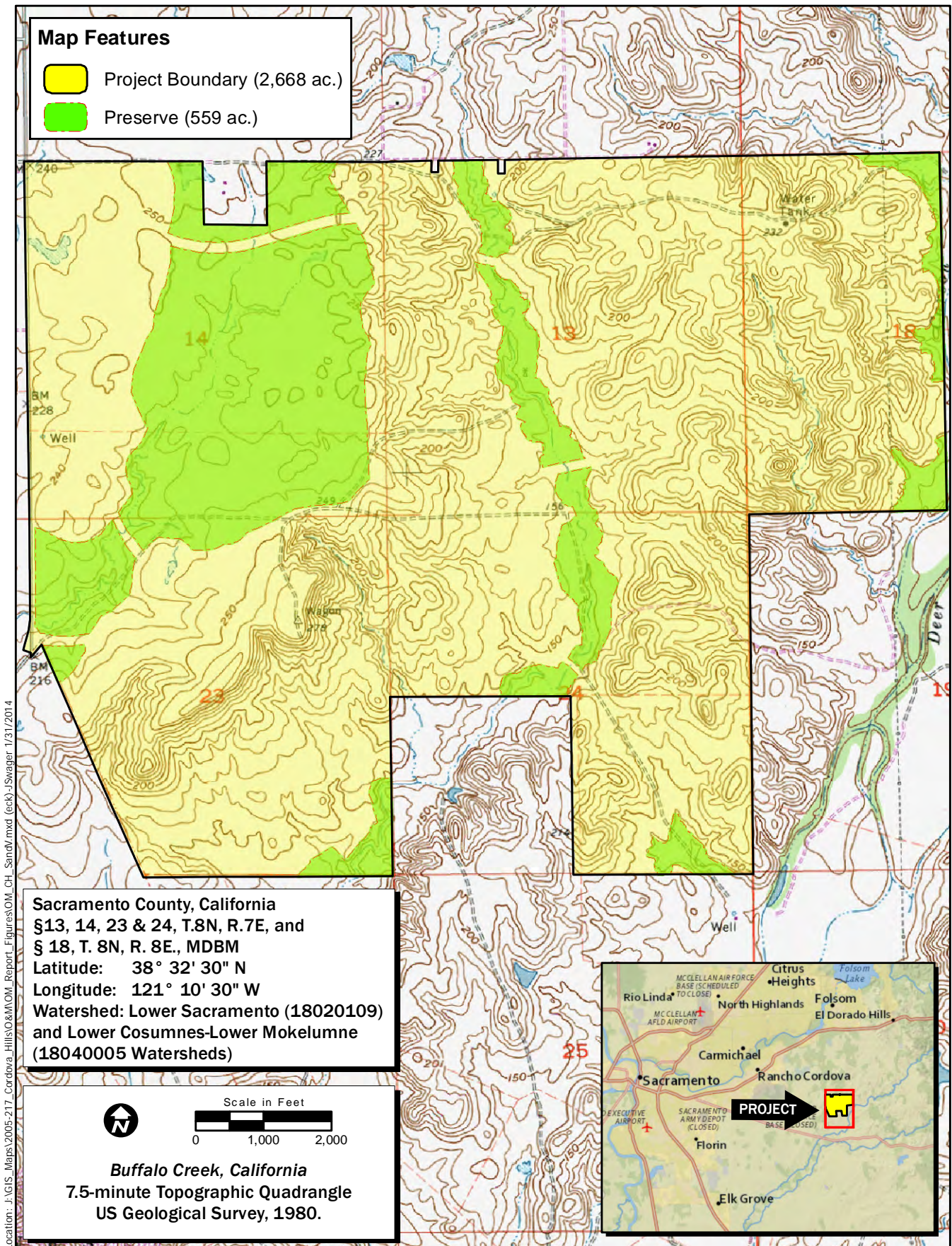
- Attachment A – On-Site Wetland Preservation Analysis for Cordova Hills
- Attachment B – Vernal Pool Mitigation and Monitoring Plan for the Shehadeh Property
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- Attachment D – Site Evaluation, Hydrological Potential, and Conceptual Onsite Seasonal and Vernal Pool Wetland Creation Opportunities for the Carson Creek Property

1.0 SUMMARY

This Conceptual Wetland Mitigation Proposal (Proposal) has been prepared for the proposed Cordova Hills Project (Project). This Proposal was prepared to provide information to the U.S. Army Corps of Engineers (USACE), the U.S. Fish and Wildlife Service (USFWS), the Environmental Protection Agency (EPA) (collectively, Regulatory Agencies) and the public regarding the mitigation package that has been proposed by the Project applicant to offset impacts to Waters of the U.S. and species listed as threatened or endangered under the federal Endangered Species Act (FESA). The purpose of the proposed mitigation is to minimize and provide compensatory mitigation for unavoidable impacts resulting from the Project. It is anticipated that final mitigation monitoring plans, long-term management plans and financial assurance, as appropriate, will be developed for each off-site mitigation property as well as the on-site preserves as required under USACE regulation and the biological opinion as the USACE reviews and approves the final mitigation plan.

The Project is approximately 2,668 acres in size and is located immediately east of Grant Line Road and south of Glory Lane, in the southeast portion of Sacramento County (Figure 1. *Cordova Hills Location and Vicinity*). The Project consists of a mixture of different land uses, including residential, senior housing, retail, commercial, and a private university, as well as parks and open space. A total of 89.467 acres of Waters of the U.S. have been delineated on the Project site; including vernal pools, seasonal wetlands, seasonal wetland swales, seeps, intermittent drainages, a perennial creek, and man-made stock ponds. The Project as proposed would impact approximately 43.539 acres of Waters of the U.S., including wetlands. These impacts include 43.179 acres of on-site impacts and 0.360 acre of off-site impacts; all anticipated off-site impacts are direct. Of the on-site impacts, 40.929 acres are direct impacts and 2.249 acres are indirect impacts to Waters of the U.S., a subset of which provide habitat for federally-listed vernal pool species, including the threatened vernal pool fairy shrimp (*Branchinecta lynchi*) and the endangered vernal pool tadpole shrimp (*Lepidurus packardii*). Collectively, the vernal pool fairy shrimp and the vernal pool tadpole shrimp are referred to as vernal pool crustaceans. The endangered Sacramento Orcutt grass (*Orcuttia viscida*) is also present on the Project site; all occupied habitat is located entirely within the on-site preserve system.

Mitigation for impacts to Waters of the U.S., including potential habitat for vernal pool crustaceans, is proposed to occur at three off-site mitigation properties, as well as within four on-site wetland preserves. The three off-site properties include the Chester Drive Property, Shehadeh Property, and the Carson Creek East Property, (collectively, Mitigation Properties) (Figure 2. *Cordova Hills and Mitigation Properties Locations*). As the USACE review of the proposed Project continues, additional mitigation sites may become available and will be evaluated by the Applicant and the USACE to ensure that unavoidable impacts to waters of the U.S. will be compensated for. A total of approximately 39.183 acres of Waters of the U.S. occur within the Mitigation Properties, resulting in a total off-site preservation amount of 39.183 acres of Waters of the U.S. Of these, 21.841 acres provide potential habitat for the federally-threatened vernal pool fairy shrimp and endangered vernal pool tadpole shrimp. Additionally, approximately 32.840 acres of wetland restoration/creation is proposed to occur within the Mitigation Properties and on-site, some of which may provide habitat for vernal pool crustaceans once established. Based on the USACE direction to provide mitigation within the Mather Core area to the extent practicable, a mix of the purchase of credits at Regulatory Agency-approved mitigation bank(s) or proposed. Permittee-responsible mitigation is the primary source of mitigation proposed for this project due to a lack of available Regulatory Agency-approved mitigation banks within the Mather Core Area.



Map Date: 1/31/2014
 Service Layer Credits: National Geographic, Esri, DeLorme,
 NAVTEQ, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN,

Figure 1. Cordova Hills Location and Vicinity

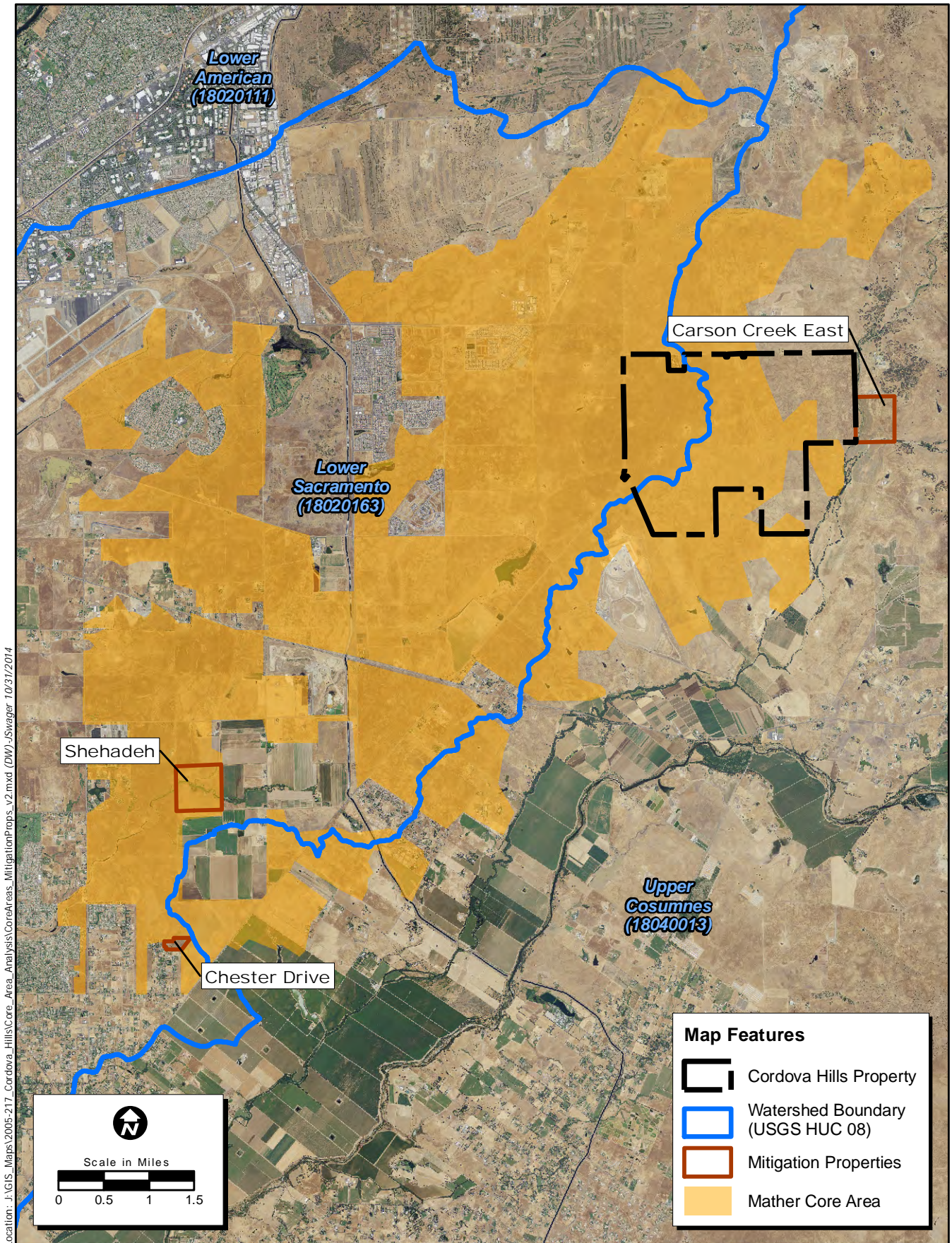


Figure 2. Cordova Hills and Mitigation Properties Locations

The Project is designed to avoid to the extent practicable direct and indirect impacts to wetlands and other Waters of the U.S. within four on-site preserves. The on-site preserves will include all areas to be avoided by the Project plus a preserve “edge treatment”. The incorporation of edge treatments will provide a substantial transition zone buffer to the on-site preserves from adjacent build-out, which will limit indirect impacts. These buffers are located outside of the preserve boundaries proper and consist of open space, trails, drainage corridors, hydrological barriers (swales), native straw seeding, detention basins, and fencing. In addition, the preserve boundaries have been placed to the extent practicable along micro-watershed boundaries to minimize edge effects. The Project will avoid a total of 45.928 acres of Waters of the U.S., which includes 34.328 acres of vernal pool crustacean habitat, as well as all wetlands known to be occupied by Sacramento Orcutt grass. The Project’s on-site preserves, as well as an analysis of impact and preservation calculations, including a detailed discussion of the Project’s proposed edge treatments, is detailed in *On-Site Wetland Preservation Analysis for Cordova Hills*, provided as Attachment A. While the acreage of anticipated preservation credit within the on-site preserves is presented below, refer to Attachment A for additional information on these preserves, including how preservation credit was calculated.

We have based the analysis in this Proposal largely on the importance of in-watershed mitigation for the purposes of the USACE. The Project site is bisected by two 8-digit HUC watersheds, the Lower Sacramento and the Upper Cosumnes. As discussed in the Record of Decision for the nearby Sun Ridge Project and guidance from the USACE, impacts to vernal pools have been analyzed independently from the 8-digit HUC watersheds. For the purposes of no-net-loss mitigation for vernal pools, the applicant has proposed to mitigate for impacts to vernal pools within the Mather Core Recovery Area (MCA), as defined in the USFWS Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon [Recovery Plan], USFWS 2005), within the MCA. The applicant has also attempted to secure as much vernal pool crustacean habitat preservation within the MCA as practicable in order to further the goals and objectives of the Recovery Plan.

The following Proposal details the Project’s proposed off-site mitigation properties, on-site preservation acreages, proposed mitigation ratios, and how the mitigation is proposed to be accomplished. Impacts and corresponding mitigation to Waters of the U.S., including those that are potential habitat for the vernal pool crustaceans, are proposed to be phased corresponding to the Project’s development phasing (Figure 3. *Wetland Preserves, Edge Treatments & Impacts by Phase*). Sufficient mitigation, including the creation and preservation of Waters of the U.S. and vernal pool crustacean habitat, will be acquired in advance of impacts to Waters of the U.S. for each phase to fulfill the mitigation obligations of the forthcoming Project permits. It should be noted that the mitigation properties presented in this Proposal have been discussed during the planning process with the USACE from 2012-present and the USFWS from 2012-2013.

Location: J:\GIS_Maps\2005-217_Cordova_Hills\AlternativesAnalysis\OnSite\20131003\404_Preserves_and_EdgeTreatment_20131028_wPhasing_Rev20141008.mxd (ECK/IDS)-J.Svager 10/8/2014

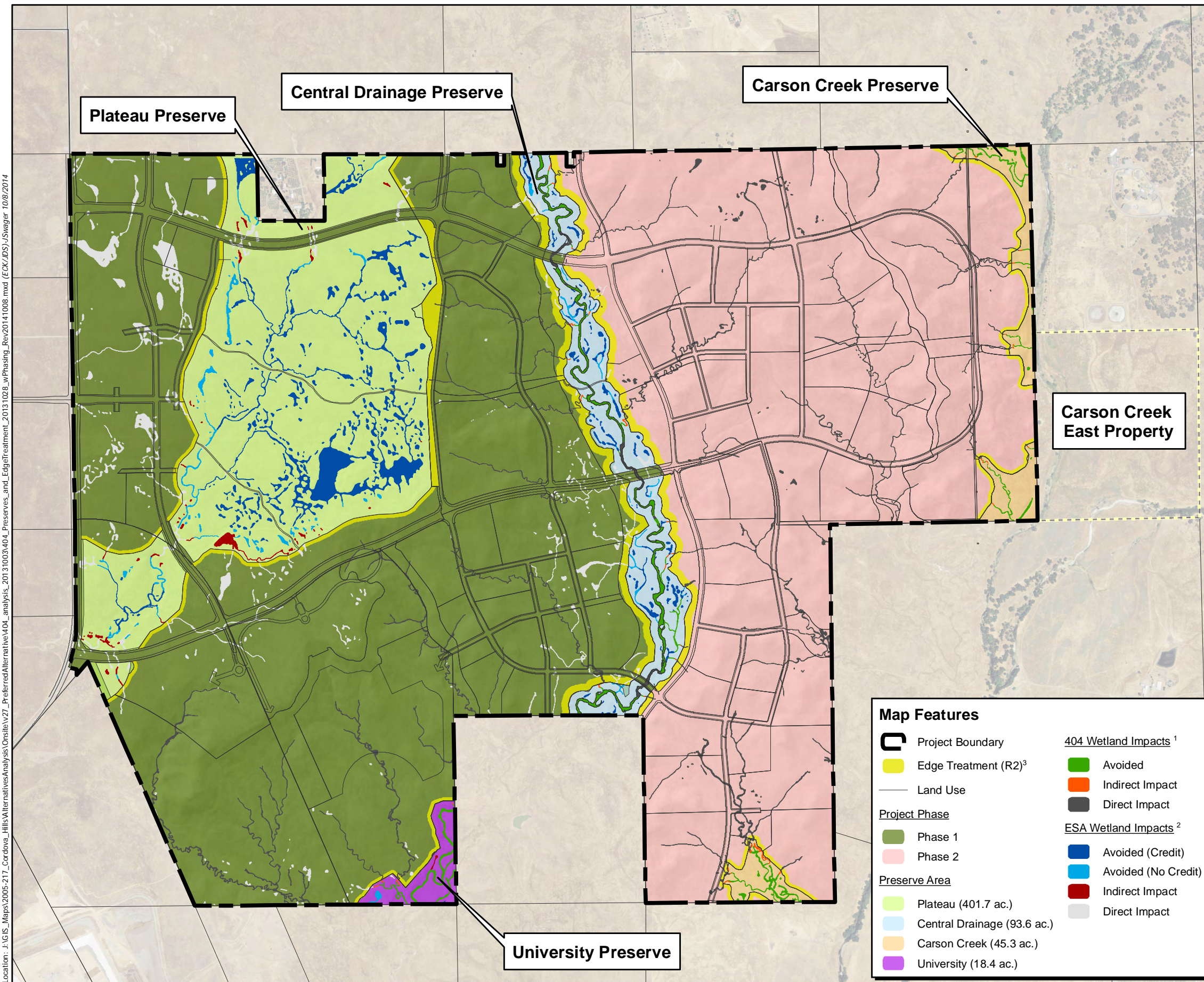



Figure 3.
Wetland Preserves,
Edge Treatments & Impacts by Phase

Wetland Impact by Shrimp Habitat and Wetland Type	Project Phase			Grand Total
	Phase1	Phase 2	Preserve	
404 Avoided	0.000	0.000	11.600	11.600
Creek	0.000	0.000	0.174	0.174
Intermittent Drainage	0.000	0.000	9.360	9.360
Seasonal Wetland	0.000	0.000	0.106	0.106
Seasonal Wetland Swale	0.000	0.000	1.431	1.431
Vernal Pool	0.000	0.000	0.530	0.530
404 Direct Impact	7.009	9.924	1.339	18.272
Intermittent Drainage	2.450	2.073	1.246	5.769
Seasonal Wetland	0.000	0.656	0.000	0.656
Seasonal Wetland Swale	4.559	5.721	0.093	10.373
Seep	0.000	0.012	0.000	0.012
Vernal Pool	0.000	1.462	0.000	1.462
404 Indirect Impact	0.000	0.001	0.377	0.378
Intermittent Drainage	0.000	0.000	0.119	0.119
Seasonal Wetland Swale	0.000	0.001	0.248	0.249
Vernal Pool	0.000	0.000	0.010	0.010
ESA Avoided (Credit)	0.004	0.000	29.860	29.863
Intermittent Drainage	0.000	0.000	0.475	0.475
Seasonal Wetland	0.004	0.000	1.460	1.464
Seasonal Wetland Swale	0.000	0.000	1.730	1.730
Stock Pond	0.000	0.000	0.035	0.035
Vernal Pool	0.000	0.000	26.159	26.159
ESA Avoided (No Credit)	0.023	0.000	4.442	4.465
Intermittent Drainage	0.000	0.000	0.741	0.741
Seasonal Wetland	0.000	0.000	0.075	0.075
Seasonal Wetland Swale	0.023	0.000	1.054	1.076
Vernal Pool	0.000	0.000	2.572	2.572
ESA Direct Impact	21.371	0.076	1.211	22.658
Intermittent Drainage	0.090	0.006	0.245	0.341
Seasonal Wetland	2.295	0.000	0.008	2.303
Seasonal Wetland Swale	2.874	0.070	0.181	3.125
Stock Pond	0.688	0.000	0.000	0.688
Vernal Pool	15.423	0.000	0.777	16.201
ESA Indirect Impact	0.001	0.000	1.870	1.871
Intermittent Drainage	0.001	0.000	0.093	0.094
Seasonal Wetland	0.000	0.000	0.167	0.167
Seasonal Wetland Swale	0.000	0.000	0.236	0.236
Stock Pond	0.000	0.000	0.799	0.799
Vernal Pool	0.000	0.000	0.575	0.575
Grand Total	28.407	10.000	50.699	89.107

1 - Non-Branchiopod Habitat Wetlands within 50 feet of Preserve edge are considered Indirectly Impacted

2 - All Non Directly Impacted Depressional Features within Central Drainage are Classified as Avoided.

3 - Edge Treatment consists of 50 ft. exterior addition to all preserve areas, except for the Central Drainage, which has a 100 ft. buffer except where this would encroach upon planned development areas.



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ENVIRONMENTAL CONSULTANTS



2.0 RESPONSIBLE PARTIES

2.1 Applicant

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2.2 Present and Long-term Owner of the Mitigation Properties

To be determined for each Mitigation Property.

2.3 Parties Responsible for Long-Term Maintenance of the Mitigation Properties

To be determined for each Mitigation Property.

2.4 Preparer of the Mitigation Proposal

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3.0 PROJECT REQUIRING MITIGATION

3.1 Location of Project

The approximately 2,668-acre Project site is located in unincorporated eastern Sacramento County, California. The site is bordered to the west by Grant Line Road. Glory Lane, a dirt road since the 1930's, abuts the Project to the north. The eastern and southern boundaries are not marked by physical features such as roads. Generally, the site is north of Kiefer Road and west of the Carson Creek drainage (see Figure 1). The site corresponds to portions of Sections 13, 14, 23 and 24, Township 8 North, and Range 7 East [Mount Diablo Base Meridian (MDBM)] and Section 18, Township 8 North, and Range 8 East (MDBM) of the "Buffalo Creek, California" 7.5-minute quadrangle (U.S. Department of the Interior, Geological Survey [USGS], 1980). The approximate center of the Project is located at 38° 32' 30" North and 121° 10' 30" West within the Lower Sacramento River and Lower Cosumnes-Lower Mokelumne Watersheds (#18020109 and #18040005, respectively, USGS 1978).

3.2 Summary of Overall Project

The approximately 2,688-acre Project consists of a mixture of planned land uses. The Project will include approximately 1,000 gross acres of residential uses ranging in density from 1 dwelling unit per net acre to 40 units per net acre, with an overall average net residential density of 10 dwelling units per acre. The Project may also contain a senior housing component. In addition, the Project will include approximately 1.38 million square feet of retail and commercial space, and a university/college campus center situated on approximately 240 acres. The university/college campus center will be designed to provide a residential learning environment, with sufficient capacity to provide on-campus housing to the majority of the approximately 6,000 students anticipated upon build out. In addition to the university/college campus center, the Project will accommodate the growing educational facility needs of the region by providing sites for the development of future elementary and secondary schools. The retail, commercial, institutional and residential uses are planned for various locations throughout the Project, including a unique "Town Center" which will be located in the western portion of the Project.

The Project includes approximately 559 acres of on-site preserves to protect Waters of the U.S. and federally-listed and other special-status species. These areas will be protected and managed in perpetuity for the benefit of these resources (Attachment A). Project design took into account existing terrain and drainage patterns, and includes Low Impact Development (LID) design concepts (outlined in the Project's Specific Plan Area Master Plan, which has been adopted by Sacramento County), as well as extensive edge treatments, which include a combination of trails, drainage swales, and native and/or drought tolerant landscaping to buffer the on-site preserves from the long-term effects of development.

3.3 Regulatory History of the Project

On 28 April 2008, the applicant submitted an application to the USACE for an Individual Permit (Permit) under Section 404 of the Clean Water Act (CWA) for the Project. Due to Project modifications, including a significant increase in on-site preservation, an amended Section 404 permit application was submitted to the USACE on 15 March 2011.

3.4 Impact and Preservation Analysis of Jurisdictional Waters of the U.S.

Table 1 outlines the direct and indirect impacts as well as on-site preservation anticipated as part of the Project. Jurisdictional Waters of the U.S. present within the overall Project (including the off-site road improvements area) include 47.590 acres of vernal pools, 4.770 acres of seasonal wetland, 18.265 acres of seasonal wetland swale, 0.012 acre of seep, 16.899 acres of intermittent drainage, 0.283 acre of creek/stream, 1.522 acres of man-made stock ponds, 0.025 acre of seasonal impoundment, and 0.099 acre of roadside ditch. See Section 3.3.4 for a detailed description of each wetland type. Attachment A, details the analysis used in determining each avoidance/impact category, and ECORP and the Project applicant worked closely with the USFWS in determining an appropriate impact and avoidance strategy. For the purposes of mitigation planning, it has been assumed that Waters of the U.S. categorized as "Avoided (No Preservation Credit)" will not be impacted and will not require mitigation. Waters of the U.S. that are categorized as "Avoided (Preservation Credit)" will count towards the project's mitigation requirements for direct and indirect impacts. A summary of the impact and preservation analysis for the Project are summarized in Table 1 below.

Table 1 – Cordova Hills Wetlands/Waters of the U.S. Preserve/Impact Acreages				
Wetland/Waters Type	Impact Type		Preserved	Total
	Direct*	Indirect		
Vernal Pool	17.744	0.585	29.261	47.590
Seasonal Wetland	2.959	0.167	1.644	4.770
Seasonal Wetland Swale	13.544	0.484	4.237	18.265
Seep	0.012	--	--	0.012
Intermittent Drainage	6.110	0.214	10.576	16.899
Creek/Stream	0.109	--	0.174	0.283
Stock Pond	0.688	0.799	0.035	1.522
Seasonal Impoundment	0.025	--	--	0.025
Roadside Ditch	0.099	--	--	0.099
Total	41.290*	2.249	45.928	89.467*

* These numbers include 0.081 acres of vernal pool, 0.046 acres of seasonal wetland swale, 0.109 acre of creek/stream, 0.025 acres of seasonal impoundment, and 0.099 acre of roadside ditch for off-site road impacts.

3.5 Existing Site Conditions

3.5.1 Topography and Hydrology

The Project site is generally comprised of level to steeply rolling topography and is situated at elevations ranging from 130 to 278 feet above mean sea level (MSL). The western portion of the site is a relatively flat terrace supporting a number of vernal pool complexes at an approximate average elevation of 245 feet above MSL. The central portion of the site is comprised of the valley formed by an intermittent tributary to Deer Creek, which drains from north to south. The eastern portion of the site is occupied by a series of steeply rolling hills and Carson Creek along the eastern boundary. The site contains an annual grassland community that is interspersed with complexes of ephemeral wetlands (i.e., vernal pools, seasonal wetlands, and seasonal wetland swales) and intermittent drainages. Two stock ponds are located in the western portion of the site, and Carson Creek borders the project along a portion of its eastern boundary. The intermittent drainages on-site are tributary to Deer Creek and Laguna Creek. The site has traditionally been used as pastureland for livestock grazing. Surrounding land uses include rural

residences, roadways, a landfill, and cattle pastures. Residential development is ongoing in the Sunrise – Douglas Community Plan and associated specific plans, which are located immediately west of the project area.

3.5.2 Vegetation

The site is comprised of annual grassland. This community is dominated by non-native naturalized Mediterranean grasses including medusahead grass (*Elymus caput-medusae*), ripgut brome (*Bromus diandrus*), soft brome (*Bromus hordeaceus*), wild oats (*Avena fatua*), and ryegrass (*Festuca perennis*). Other herbaceous species in this community included rose clover (*Trifolium hirtum*), bicolored lupine (*Lupinus bicolor*), cut-leaf geranium (*Geranium dissectum*), common vetch (*Vicia sativa*), filaree (*Erodium botrys*), sticky tarweed (*Holocarpha virgata*), Fitch's spikeweed (*Centromadia fitchii*), yellow star-thistle (*Centaurea solstitialis*), hairy hawkbit (*Leontodon saxatalis*), and turkey mullein (*Croton setigerus*).

3.5.3 Soils

According to the *Soil Survey of Sacramento County, California* (U.S. Department of Agriculture, Soil Conservation Service 1993), 16 soil units, or types have been mapped within the Project area (Figure 4. *Natural Resource Conservation Service [NRCS] Soils Types* and Table 2).

Map Unit Number	Map Unit Name	Hydric Components	Hydric Inclusions
101	Amador-Gillender complex, 2-15% slopes	N	N
125	Corning complex, 0-8% slopes	Y	N
126	Corning-Redding complex, 8-30% slopes	N	N
132	Creviscreek sandy loam, 0-3% slopes	N	N
156	Hadselville-Pentz complex, 2-30% slopes	N	N
158	Hicksville loam, 0-2% slopes	N	Y
160	Hicksville sandy clay loam, 0-2% slopes	N	Y
163	Keyes sandy loam, 2-15% slopes	N	N
187	Pardee-Rancho Seco complex, 2-5% slopes	N	N
188	Pentz-Lithic xerothents complex, 30-50% slopes	N	N
189	Peters clay, 1-8% slopes	N	N
192	Red Bluff loam, 2-5% slopes	N	Y
193	Red Bluff-Redding complex, 0-5% slopes	N	Y
198	Redding gravelly loam, 0-8% slopes	N	Y
215	San Joaquin silt loam, 3-8% slopes	N	Y
242	Xerofluvents, 0-2% slopes	Y	Y

¹Source: Sacramento County Hydric Soils List

3.5.4 Waters of the U.S.

Three separate wetland delineations were conducted by ECORP within the Project site. These wetland delineations were conducted in accordance with the *Corps of Engineers Wetlands Delineation Manual* ([USACE Manual], Environmental Laboratory 1987). All three of these wetland delineations have been verified by the USACE (Regulatory Number SPK-2004-00116). These three wetland delineations cover the entire Project site and the various wetland habitats found within the Project are described below and shown in Figure 5. *Wetland Preserves, Edge Treatments & Impacts by HUC 8.*

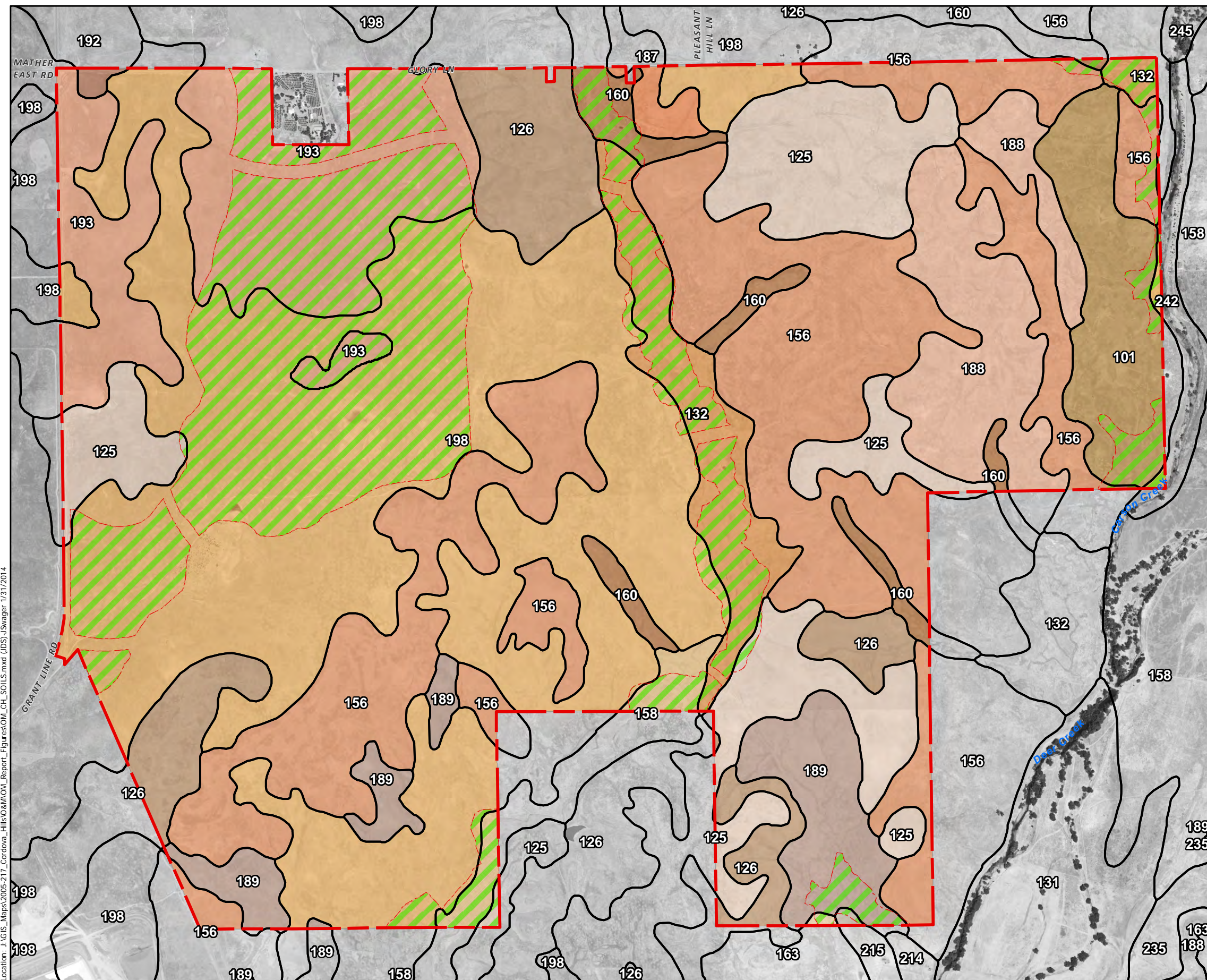


Figure 4.
NRCS Soil Types

Map Features

- Cordova Hills Project Boundary
- Preserve

Series Number - Series Name

- 101 - Amador-Gillender complex, 2-15% slopes
- 125 - Corning complex, 0-8% slopes
- 126 - Corning-Redding complex, 8-30% slopes
- 132 - Creviscreek sandy loam, 0-3% slopes
- 156 - Hadselville-Pentz complex, 2-30% slopes
- 158 - Hicksville loam, 0-2% slopes, occasionally flooded
- 160 - Hicksville sandy clay loam, 0-2%, occasionally flooded
- 163 - Keyes sandy loam, 2-15% slopes
- 187 - Pardee-Ranchoseco complex, 3-15% slopes
- 188 - Pentz-Lithic Xerorthents complex, 30-50% slopes
- 189 - Peters clay, 1-8% slopes
- 192 - Red Bluff loam, 2-5% slopes
- 193 - Red Bluff-Redding complex, 0-5% slopes
- 198 - Redding gravelly loam, 0-8% slopes
- 215 - San Joaquin silt loam, 3-8% slopes
- 242 - Xerofluvents, 0-2% slopes, flooded

Natural Resources Conservation Service (NRCS)
Soil Survey Geographic (SSURGO) Database for
Sacramento County, CA



Location: J:\GIS_Maps\2005-217_Cordova_Hills\AlternativesAnalysis\OnSite\27_PreferedAlternative\404_analysis_20131003\404_Preserves_and_EdgeTreatment_20131028_wHUC8.mxd (ECK/JDS) /Swager 9/25/2014

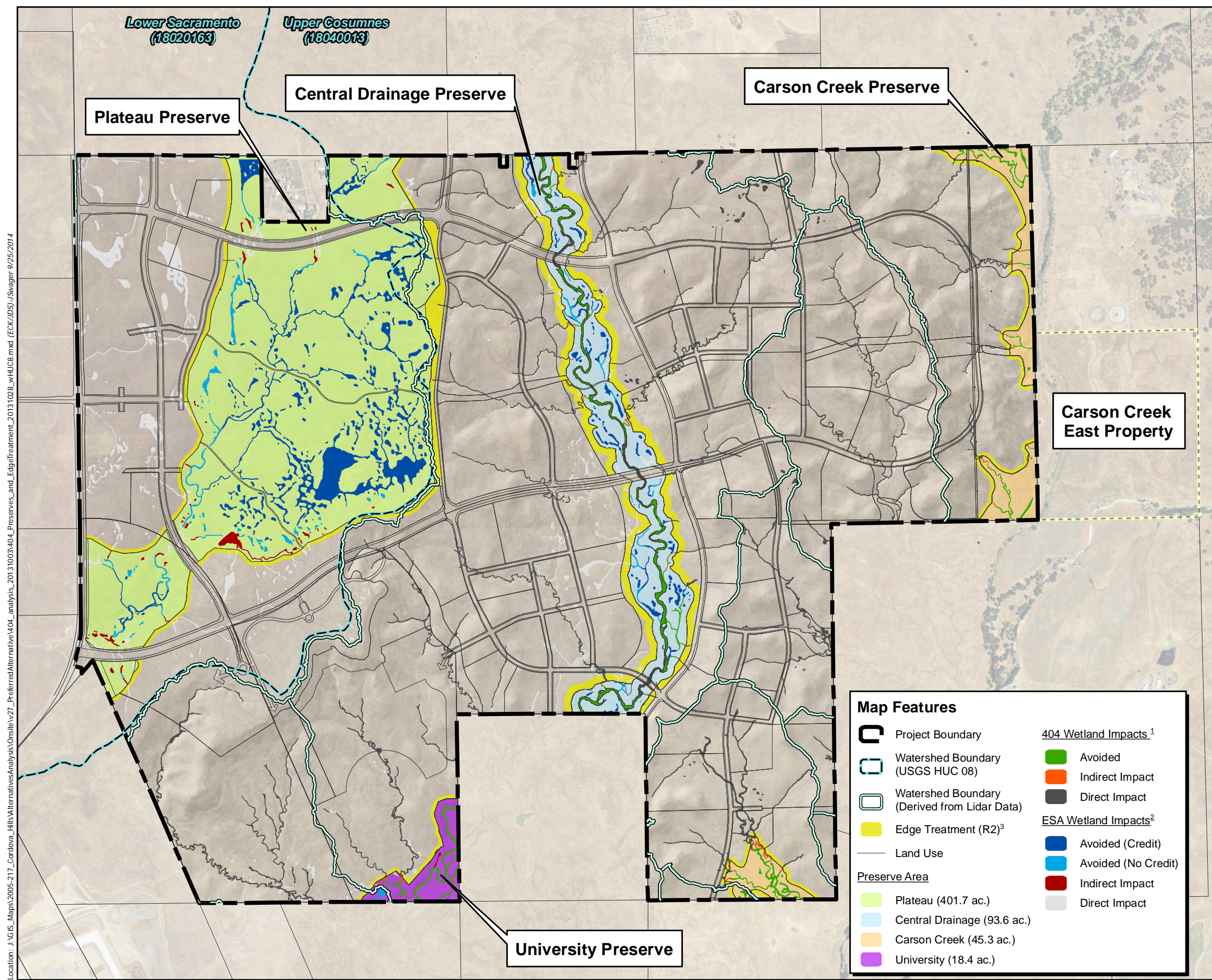


Figure 5
Wetland Preserves,
Edge Treatments & Impacts by HUC 8

Wetland Impact by Shrimp Habitat and Wetland Type	HUC8 Watersheds		Grand Total
	Lower Sacramento	Upper Cosumnes	
404 Avoided	0.000	11.600	11.600
Creek	0.000	0.174	0.174
Intermittent Drainage	0.000	9.360	9.360
Seasonal Wetland	0.000	0.106	0.106
Seasonal Wetland Swale	0.000	1.431	1.431
Vernal Pool	0.000	0.530	0.530
404 Direct Impact	0.000	18.272	18.272
Intermittent Drainage	0.000	5.769	5.769
Seasonal Wetland	0.000	0.656	0.656
Seasonal Wetland Swale	0.000	10.373	10.373
Seep	0.000	0.012	0.012
Vernal Pool	0.000	1.462	1.462
404 Indirect Impact	0.000	0.378	0.378
Intermittent Drainage	0.000	0.119	0.119
Seasonal Wetland Swale	0.000	0.249	0.249
Vernal Pool	0.000	0.010	0.010
ESA Avoided (Credit)	25.865	3.999	29.863
Intermittent Drainage	0.475	0.000	0.475
Seasonal Wetland	0.740	0.724	1.464
Seasonal Wetland Swale	1.381	0.349	1.730
Stock Pond	0.035	0.000	0.035
Vernal Pool	23.234	2.926	26.159
ESA Avoided (No Credit)	3.368	1.097	4.465
Intermittent Drainage	0.734	0.008	0.741
Seasonal Wetland	0.075	0.000	0.075
Seasonal Wetland Swale	0.343	0.733	1.076
Vernal Pool	2.215	0.357	2.572
ESA Direct Impact	16.670	5.987	22.658
Intermittent Drainage	0.331	0.010	0.341
Seasonal Wetland	0.553	1.750	2.303
Seasonal Wetland Swale	1.450	1.674	3.125
Stock Pond	0.688	0.000	0.688
Vernal Pool	13.648	2.553	16.201
ESA Indirect Impact	1.789	0.083	1.871
Intermittent Drainage	0.094	0.000	0.094
Seasonal Wetland	0.167	0.000	0.167
Seasonal Wetland Swale	0.215	0.020	0.236
Stock Pond	0.799	0.000	0.799
Vernal Pool	0.512	0.062	0.575
Grand Total	47.692	41.415	89.107

1 - Non-Branchiopod Habitat Wetlands within 50 feet of Preserve edge are considered Indirectly Impacted
2 - All Non Directly Impacted Depressional Features within Central Drainage are Classified as Avoided.
3 - Edge Treatment consists of 50 ft. exterior addition to all preserve areas, except for the Central Drainage, which has a 100 ft. buffer except where this would encroach upon planned development areas.

ECORP Consulting, Inc.
ENVIRONMENTAL CONSULTANTS

For off-site road improvement areas, ECORP did not have physical access to conduct a wetland delineation in accordance with the USACE Manual. In these areas, Six Counties Aquatic Resources Inventory ([SCARI], USACE 2011) data were utilized, along with aerial photography interpretation, to determine potential wetland extents and classifications (ECORP 2013a). A site visit with the USACE was conducted on 15 April 2013 and a preliminary jurisdictional determination was issued by the USACE on 10 May 2013, which identified 0.320 acres of potentially jurisdictional Waters of the U.S. To the extent possible, general conditions of these Waters of the U.S. are detailed in the sections below.

Vernal Pool

A total of 47.509 acres of vernal pools were mapped on-site within the Project and 0.081 acre of vernal pool was mapped within the off-site road improvement areas. Vernal pools are scattered through the site's annual grassland habitats and are topographic basins within the grassland community and typically are underlain with an impermeable or semi-permeable hardpan or duripan layer. Vernal pools typically are inundated through the wet season and are dry by late spring through the following wet season. The composition of plant species within the vernal pools on-site is predominantly native annual species that include little quaking grass (*Briza minor*), creeping spikerush (*Eleocharis macrostachya*), double-horned downingia (*Downingia bicornuta*), Solano downingia (*Downingia ornatissima*), Vasey's coyote-thistle (*Eryngium vaseyi*), white-head navarretia (*Navarretia leucocephala*), smooth goldfields (*Lasthenia glaberrima*), slender popcorn flower (*Plagiobothrys stipitatus*), Mediterranean barley (*Hordeum marinum*), toad rush (*Juncus bufonius*), ryegrass, and Carter's buttercup (*Ranunculus bonariensis*).

Seasonal Wetland

A total of 4.770 acres of seasonal wetlands were mapped within the Project. Seasonal wetlands are ephemeral wet areas where runoff accumulates within low-lying depressions and/or adjacent to watercourses. Inundation periods tend to be relatively short and are commonly dominated by non-native annual, and sometimes perennial, hydrophytic species. The dominant wetland vegetation found in seasonal wetland areas on-site includes creeping spikerush, Vasey's coyote-thistle, toad rush, ryegrass, Carter's buttercup, and spiny-fruit buttercup (*Ranunculus muricatus*).

Seasonal Wetland Swale

A total of 18.219 acres of seasonal wetland swale were mapped within the Project and 0.046 acre of vernal pools was mapped within the off-site road improvements area. Seasonal wetland swales are shallow, ephemeral wet areas that convey water between larger drainages or other Waters of the U.S. features during storm events. They usually occur as linear features. Wetland swales may remain saturated into the growing season and support hydrophytic vegetation and exhibit hydric soil characteristics. The dominant wetland vegetation observed in seasonal wetland swales on-site included, creeping spikerush, Vasey's coyote-thistle, Mediterranean barley, toad rush, ryegrass, slender popcorn-flower, Carter's buttercup, and cut-leaf geranium (*Rumex crispus*).

Seep

A total of 0.012 acre of seep occurs within the Project area. Seeps are seasonally or perennially wet areas resulting from discharge of groundwater to the surface. The seeps are located on a hillside in the southeastern portion of the property. Dominant plant species identified in the seeps included iris-leaf rush (*Juncus xiphioides*), white-tip clover (*Trifolium variegatum*), and ryegrass. Other species found in the seeps include cut-leaf geranium and common coyote thistle.

Intermittent Drainage

A total of 16.899 acres of intermittent drainage were mapped within the Project. Intermittent drainages are linear features that exhibit an ordinary high water mark (OHWM). These features tend to be unvegetated due to the depth and scouring effects of flowing water. Plants observed sparsely within the intermittent drainages on-site include ryegrass, hairy hawkbit, toad rush, brome fescue (*Vulpia bromoides*), Vasey's coyote-thistle, Carter's buttercup, creeping spikerush, and bractless hedge-hyssop (*Gratiola ebracteata*).

Creek

A total of 0.174 acres of Carson Creek was mapped within the Project site, and 0.085 acre of Laguna Creek and 0.024 acre of unnamed creeks were mapped within the off-site road improvements area. Carson Creek is a seasonal feature that conveys runoff following rain events and support intermittent pools and year-round water in deeper scour pools. The substrate within the channel is a matrix of sand, gravel, silt, and small boulders. The stream channel has well-defined banks with an OHWM, and is largely unvegetated due to the scouring effects of fast moving water. Large cottonwoods (*Populus fremontii*) occur in scattered areas along portions of the creek margin, although not within the project site. The portions of Laguna Creek and unnamed creeks within the off-site road improvements area have a less defined bed and bank, and are largely lacking riparian vegetation.

Stock Pond

A total of 1.522 acres of stock pond was mapped within the Project. Stock ponds are ephemeral or perennial, deep, water filled basins that are human made and generally used for water storage for irrigation or cattle grazing. As with other seasonally wet areas, the periodically inundated margins of the ponds support seasonal wetland vegetation including toad rush, ryegrass, and spiny-fruit buttercup. The deeper portions of these pond supported emergent aquatic vegetation including white water buttercup (*Ranunculus aquatilis*) and mannagrass (*Glyceria declinata*).

Roadside Ditch

A total of 0.099 acre of roadside ditch was mapped within the off-site road improvements area. These ditches are generally barren to sparsely vegetated, with a base of rock or gravel in some places, and are flashy features that convey road runoff for short durations.

Seasonal Impoundment

A total of 0.025 acre of seasonal impoundment was mapped within the off-site road improvements area. These areas appeared to be similar to vernal pools and swales in the area, but were classified based on SCARI wetland data types (USACE 2011).

3.6 Federally-Listed Species

Two species of federally-listed vernal pool crustaceans and one species of federally-listed plant are known to be present within the Project site and are discussed in more detail below.

3.6.1 Vernal Pool Crustaceans

Assessment level wet-season large crustacean surveys were conducted between 2 January and 4 February 2013 by ECORP biologists (ECORP 2013b). These surveys targeted the federally-listed as threatened vernal pool fairy shrimp and endangered vernal pool tadpole shrimp. During surveys, approximately 50% of all depressional wetlands (vernal pools and seasonal wetlands) and 95% of ephemeral and intermittent drainages within the entire Project site were surveyed once. Of the 944 features surveyed, listed crustaceans were only found in approximately 10% (95) of the features. The vernal pool fairy shrimp was observed in 36 aquatic features and the vernal pool tadpole shrimp was observed in 74 aquatic features (Attachment A includes all known vernal pool crustacean occurrences at Cordova Hills).

During the wet-season surveys, listed vernal pool crustaceans were identified within a total of 89 wetlands and other Waters of the U.S. on the western plateau. These occurrences account for 94% of all the crustacean occurrences on the entire Project site. Topography east and south of the western plateau becomes much steeper, and as such, the aquatic habitat becomes linear and hydrologically episodic ("flashy"). The only known occurrences outside of the western plateau are six occurrences of vernal pool fairy shrimp, which are located in depressional wetlands on the west side of the central drainage.

In addition to the 2012-2013 wet season surveys, 41 vernal pools and seasonal wetlands east of the western plateau were subsequently targeted for dry-season surveys during the summer of 2013 (ECORP 2013c). These surveys were intended to confirm the relative distribution of vernal pool crustaceans on the Project site by supplementing the broader wet-season surveys. These wetlands were selected, in consultation with the USFWS, because they appeared to provide the highest quality habitat for listed vernal pool crustaceans east of the western plateau. No evidence of federally-listed crustaceans (carapaces or cysts) was identified during these targeted dry-season surveys. No vernal pool crustaceans have been detected east of the central drainage (which corresponds to approximately the eastern half of the Project site).

Based on the locations of vernal pool crustacean occurrences on the project site, the 45.507 acres of vernal pools, 4.009 acres of seasonal wetlands, 6.167 acres of seasonal wetland swales, 1.651 acres of intermittent drainage, and 1.522 acres of stock ponds located west of the central drainage are being considered habitat for the vernal pool fairy shrimp and the vernal pool tadpole shrimp. Table 3 summarizes each on-site impact and avoidance category for vernal pool crustacean habitat (please note that these impact acreages represent a subset of those included in Table 2). The Waters of the U.S. that are categorized as "Avoided (Credit)" are being preserved on-site and are included in habitat preservation calculations. Those that are categorized as "Avoided (No Credit)" are being sufficiently avoided so that no direct or indirect impacts are anticipated, but are not considered as on-site preservation due to their relative proximity to development.

No surveys for vernal pool crustaceans have been conducted to date within the off-site road improvement areas. For planning purposes, it has been assumed that 0.081 acre of vernal pool, 0.046 acre of seasonal wetland swale, and 0.025 acre of seasonal impoundment within the off-site road improvement areas may serve as habitat for vernal pool crustaceans. These acreages are included in Table 3.

Table 3 –Wetland Impacts: Federally-Listed Crustaceans				
Habitat	Avoided (Credit)	Avoided (No Credit)	Direct Impact*	Indirect Impact
Vernal Pool	26.159	2.572	16.282	0.575
Seasonal Wetland	1.464	0.075	2.303	0.167
Seasonal Wetland Swale	1.730	1.076	3.171	0.236
Intermittent Drainage	0.475	0.741	0.341	0.094
Stock Pond	0.035	0.000	0.688	0.799
Seasonal Impoundment	0.000	0.000	0.025	0.000
Total	29.863	4.464	22.810	1.871

*These numbers include 0.081 acres of vernal pool, 0.046 acres of seasonal wetland swale, and 0.025 acre of seasonal impoundment for off-site road impacts.

3.6.2 *Special-Status Plants*

Six special-status plant surveys were conducted within the Project site between 2007 and 2011 (ECORP 2007, 2008, 2009a, 2009b, 2010, 2011). One occurrence of the federally-endangered Sacramento Orcutt grass was detected within the Project during both the 2007 and 2008 surveys. This occurrence included populations in three vernal pools within the Project site.

These three occurrences of Sacramento Orcutt grass will be avoided by project activities, and will be included within the on-site Plateau Preserve. In addition, a minimum buffer of 300 feet (except where Project boundaries limit these buffers) around each occupied vernal pool will be maintained in order to reduce indirect effects from construction activities and diminish edge effects to this species. As a result, no hydrologic impacts to the pools containing Sacramento Orcutt grass are anticipated; therefore, no mitigation for project-related impacts to Sacramento Orcutt grass has been proposed. It is anticipated that long-term management of the on-site preserves and mitigation properties will benefit Sacramento Orcutt grass.

While vernal pools that may serve as habitat for special-status plants occur within the off-site road infrastructure areas, no surveys have been done to date due to access constraints. It is not certain at this time if this Project will complete these off-site road improvements prior to another entity (the necessary road improvements are of regional importance). Should this Project fill suitable special-status plant habitat within the off-site road improvements area, targeted surveys will be completed prior to construction. The Project applicant will engage in additional consultation with the USFWS if necessary.

4.0 FRAMEWORK FOR PROPOSED MITIGATION

4.1 In-Watershed Mitigation

The analysis in this Proposal is based largely on the importance of in-watershed mitigation for the purposes of the USACE. The Project site is bisected by two distinct 8-digit HUC watersheds, the Lower Sacramento and the Upper Cosumnes. Based on the high quality watershed data that has been developed for the Project site, ECORP was able to analyze Waters of the U.S. along the watershed "break" to determine with greater accuracy which Waters of the U.S. were attributed to which watersheds in actuality (Figure 5).

The purchase of credits at Regulatory Agency-approved mitigation bank(s) or permittee-responsible responsible mitigation at other suitable properties in the vicinity of the proposed Project site is proposed. The proposed mitigation has been developed by the applicant in accordance with the USACE regulation at 33 CFR 332.3(a) which states: "When evaluating compensatory mitigation options, the district engineer will consider what would be environmentally preferable." The USACE regulation also states: "In general, the required compensatory mitigation should be located within the same watershed as the impact site, and should be located where it is most likely to successfully replace lost functions and services..." When developing this Proposal, in-watershed mitigation was given priority except for vernal pool impacts within the MCA. In-watershed mitigation will help ensure that replacement Waters of the U.S. are of similar functions and values to those impacted, and will be created/preserved in the same relative geographic location of those being impacted. Table 4 details impacts to Waters of the U.S. within each watershed. Note that vernal pool impacts within the MCA are not included here, but rather are discussed in Section 4.2 below.

Table 4. Impacts to Waters of the U.S (Non-Vernal Pool) by HUC 8 Watershed					
Waters	Lower Sacramento HUC 8 Watershed		Upper Cosumnes HUC 8 Watershed		
	Direct Impacts	Indirect Impacts	Direct Impacts	Indirect Impacts	Total
Vernal Pool (non-MCA)	0.000	0.000	1.043	0.010	1.053
Creek	0.109*	0.000	0.000	0.000	0.109
Intermittent Drainage	0.331	0.094	5.779	0.119	6.323
Seasonal Wetland	0.561	0.167	2.398	0.000	3.127
Seasonal Wetland Swale	1.555*	0.215	11.989	0.269	13.713
Seep	0.000	0.000	0.012	0.000	0.281
Stock Pond	0.688	0.799	0.000	0.000	1.467
Seasonal Impoundment	0.025*	0.000	0.000	0.000	0.025
Roadside Ditch	0.099	0.000	0.000	0.000	0.099
Total Waters of the U.S.	3.368	1.275	21.221	0.398	26.262

*These numbers include 0.046 acres of seasonal wetland swale, 0.109 acre of creek/stream, 0.025 acres of seasonal impoundment, and 0.099 acre of roadside ditch for off-site road impacts.

4.2 Vernal Pools in the Mather Core Recovery Area

A portion of the MCA, as defined in the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2005), is located on the Project site.

As discussed in the Record of Decision for the nearby Sun Ridge project and guidance from the USACE, we have analyzed impacts to vernal pools independently from the 8-digit HUC watersheds. For the purposes of no-net-loss mitigation for vernal pools, the applicant has proposed to mitigate for impacts to vernal pools that occur in the MCA within the MCA. Impacts to vernal pools within the MCA are detailed in Table 5. Due to the lack of available vernal pool creation credits from an Agency-approved mitigation bank within the MCA, it is environmentally preferable for the applicant to use permittee responsible mitigation within the MCA rather than buying credits from mitigation banks outside of the Mather Core Area. Mitigation within the MCA will ensure that replacement vernal pools are of similar quality to those impacted, share similar soils and vegetative characteristics, and generally contribute the regional goals and objectives of the Recovery Plan (USFWS 2005).

Table 5 – Vernal Pools in the Mather Core Area		
	Impacts	Proposed Creation (1:1)
Direct Impact	16.701*	16.701*
Indirect Impact	0.575	0.575
Total	17.276	17.276

*This number includes 0.081 acres of vernal pools within the off-site road improvements area.

4.3 Vernal Pool Crustacean Habitat

For the purposes of habitat preservation for federally-listed species, the applicant has also attempted to secure as much on-site and off-site preservation of Waters of the U.S. (a subset of which serves as listed species habitat) within the MCA as practicable. All directly and indirectly impacted vernal pool crustacean habitat within the Project site is located within the MCA (Attachment A). The Project applicant has attempted to meet the approximately 2.6:1 preservation to impact ratio for direct impacts to listed vernal pool crustacean habitat within the MCA that was required by the USFWS's 2 November 2011 biological opinion for the Rio del Oro Project (USFWS #81420-2010-F-0891-1), which is located approximately 2.25 miles northwest of the Project in Sacramento County.

Table 6 – Vernal Pool Crustacean Habitat in the Mather Core Area			
	Impacts	Proposed Mitigation Ratio	Proposed Preservation
Direct Impact	22.658*	2.6:1	58.911
Indirect Impact	1.871	1:1	1.871
Total	24.529		60.782

*This number includes 0.081 acres of vernal pool, 0.046 acres of seasonal wetland swale, and 0.025 acres of seasonal impoundment for off-site road impacts.

5.0 MITIGATION PROPERTIES

Three properties are proposed as off-site wetland mitigation areas for the Project. These are the Chester Drive Property, Shehadeh Property, and Carson Creek East Property (collectively, "Mitigation Properties"). The Shehadeh and Carson Creek East properties lie within seven miles of the Project and the Carson Creek East Property lies within a half mile of the Project (Figure 2). The Project site contains two HUC 8 watersheds, the Lower Sacramento and Upper Cosumnes. The Shehadeh and Chester Drive Properties

are within the Lower Sacramento watershed and the Carson Creek East property is within the Upper Consumnes watershed (Figure 2).

The Shehadeh Property is located within the MCA, and the Carson Creek East Property is outside of the MCA to the east. The Chester Drive Property is partially inside the MCA, and the large vernal pool that occurs on the Chester Drive Property is hydrologically connected to another large vernal pool on the adjacent Bryte Ranch Conservation Bank (which is mapped inside the MCA). For the purposes of this Proposal it has been assumed that the applicant will receive mitigation credit within the MCA for vernal pool restoration and preservation within the Chester Drive Property. Additional details for each of these Mitigation Properties are presented below.

5.1 Characteristics of the Proposed Mitigation Properties

5.1.1 Locations and Sizes

Chester Drive Property

The approximately 17.3-acre Chester Drive Property is located in Sections 13 and 14, Township 7 North, Range 6 East (MDBM) Sacramento County, California. The parcel can be found at UTM 650,252 M E; 4,258,065 M N (Zone 10 North) and is portrayed on the Elk Grove, California 7.5-minute quadrangle (USGS 1979)

Shehadeh Property

The approximately 160-acre Shehadeh Property (site), located south of Florin Road, east of Excelsior Road, west of Eagles Nest Road, and north of Grant Line Road, Sacramento County, California. The site corresponds to a portion of Sections 1, 2, 11 and 12 of Township 7 North, Range 6 East (MDBM) of the Elk Grove, California 7.5-minute quadrangle (USGS 1979)

Carson Creek East Property

The approximately 139-acre Carson Creek East Property is located just east of the main Project site. Because of the adjacent nature of the Carson Creek East Property, its location is very similar to the Cordova Hills property, east of the central drainage. The overall Project site corresponds to portions of Sections 13, 14, 23, and 24 of Township 8 North and Range 7 East [MDBM] and Section 18 of Township 8 North and Range 8 East (MDBM) of the Buffalo Creek, California 7.5-minute quadrangle (USGS 1980).

5.2 Ownership Status

Currently, Cordova Hills LLC has control over the Chester Drive, Shehadeh, and Carson Creek Properties through ownership or options.

5.3 Waters of the U.S.

5.3.1 Chester Drive Property

The Chester Drive Property supports jurisdictional Waters of the U.S. including 13.241 acres of vernal pool and one 0.612-acre seasonal pond (Figure 6. *Chester Drive Property Wetland Delineation*).



Figure 6.
Chester Drive Property
Wetland Delineation

5.3.2 Shehadeh Property

The Shehadeh Property supports 16.235 acres of jurisdictional waters of the U.S. including 2.677 acres of vernal pool, 1.933 acres of seasonal wetland, 3.990 acres of seasonal wetland swale, and 7.635 acres of other waters. These other waters include 0.832 acres of Frye Creek (Intermittent Drainage), and 6.803 acres of Laguna Creek (Perennial Creek) (Figure 7. *Shehadeh Property Wetland Delineation*)

5.3.3 Carson Creek East Property

The Carson Creek East property contains 0.301 acres of vernal pools, 0.966 acres of seasonal wetlands, 1.633 acres of seasonal wetland swales, and 6.165 acres of creeks. (Figure 8. *Carson Creek East Wetland Delineation*).

5.4 Proposed Creation of Waters of the U.S.

Vernal pool creation plans have been/will be developed for each proposed site to determine that each site is hydrologically suitable to sustain created Waters based upon topography of the local catchments and soil profiles and to ensure that existing vernal pools and other wetland resources will not be negatively impacted by the addition of created Waters. The proposed creation on each site will be designed to avoid impacts to existing Waters to the greatest extent practicable.

5.4.1 Cordova Hills Property (On-site)

Between 6.55 and 13.1 acres of vernal pool creation is proposed at the Cordova Hills Property. The proposed created vernal pools would be within the Plateau Preserve, and the acreage range corresponds to a 5% to 10% wetland density within creation areas. A preliminary site suitability report is included as Attachment B, and additional information is being gathered to develop a detailed creation plan for this site.

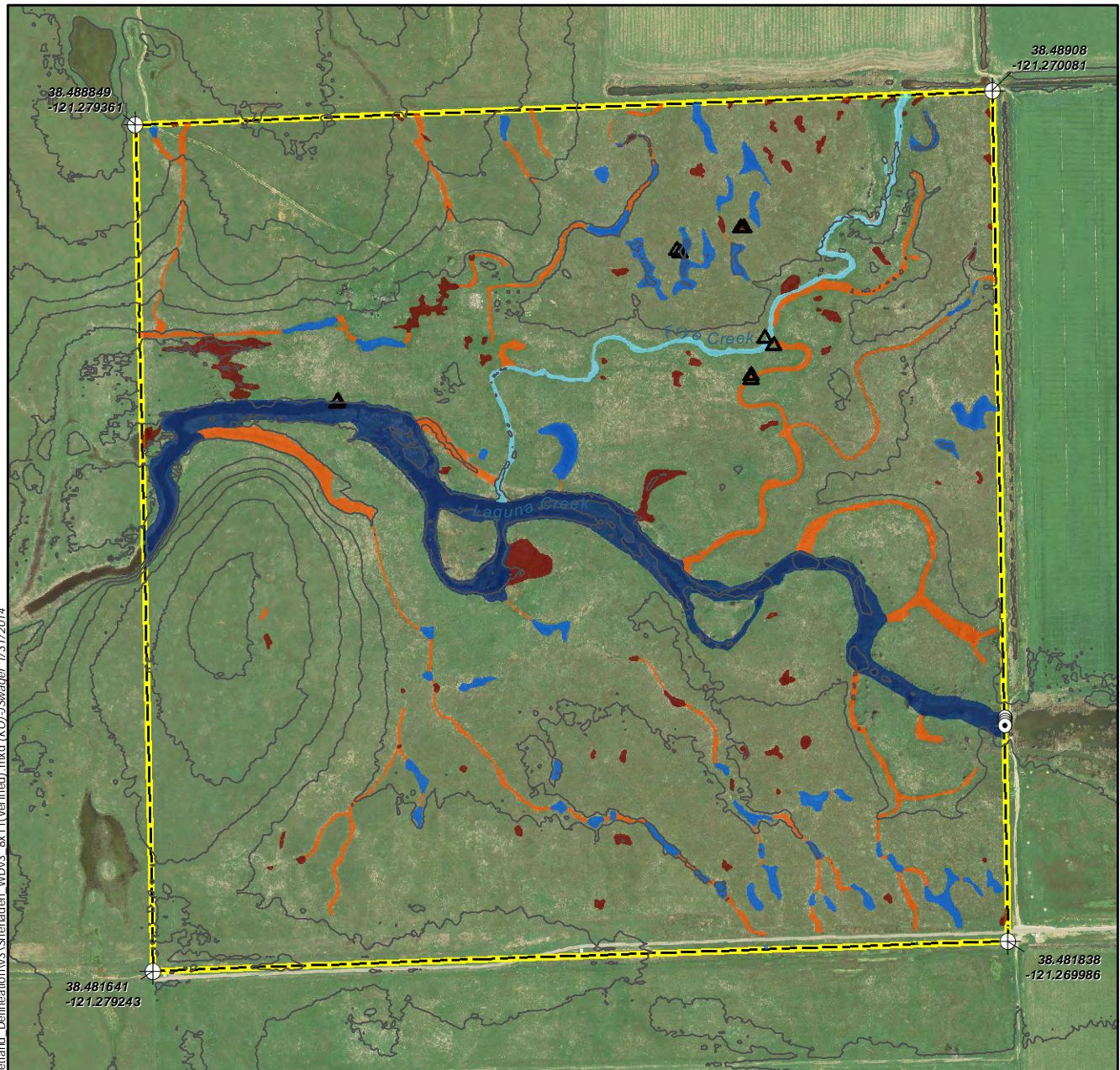
5.4.2 Chester Drive Property

Approximately 3.0 acres of vernal pool restoration is proposed at the Chester Drive Property. This creation will be achieved by removing a man-made berm, which currently bisects the approximately 13.241-acre vernal pool on the property (Figure 9. *Chester Drive Property Wetland Restoration Potential*). The vernal pool on the property is part of a larger vernal pool located on the Bryte Ranch Conservation Bank.

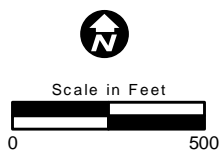
5.4.3 Shehadeh Property

Approximately 12.240 acres of vernal pool creation are proposed at the Shehadeh Property; and the proposed vernal pools to be created are distributed throughout the site. The overall vernal pool density for the Shehadeh Property would be 9.71% (Attachment C) following creation. A vernal pool creation plan for the Shehadeh Property is included as Attachment C.

Location: N:\2012\2012-099 Shehadeh Property\Wetland_Mapping\Wetland_Delineation\3_Shehadeh_WD\3_8x11(Veified).mxd (KO) - Swager 1/31/2014



- Property Boundary +/- 160 acres
- Three-criteria Sample Point
- Culvert



WATERS OF THE U.S. ACREAGE ¹

CLASSIFICATION		ACREAGE	LINEAR FT
WETLANDS:			
Vernal Pool		2.677	----
Seasonal Wetland		1.933	----
Seasonal Wetland Swale		3.990	----
OTHER WATERS:			
Frye Creek (Intermittent Drainage)		0.832	2,602
Laguna Creek (Perennial Creek)		6.803	4,547
TOTAL:		16.235	7,149

¹ Verified by U.S. Army Corps of Engineers SPK-2013-00998, November 26, 2013.
This exhibit depicts information and data produced in strict accord with the wetland delineation methods described in the 1987 Corps of Engineers Wetlands Delineation Manual and the Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region and conforms to Sacramento District specifications. However, wetland boundaries have not been legally surveyed and may be subject to minor adjustments if exact locations are required.

Map Date: 12/3/2013
Photo: USGS 2011
Delineation: T. Wood

Figure 7. Shehadeh Property Wetland Delineation

2005-217 Shehadeh Property



WETLANDS³

VERNAL POOL			
ID	SQ. FT.	ACRES	
VP-1	975	0.022	
VP-2	570	0.013	
VP-3	404	0.009	
VP-4	156	0.004	
VP-5	103	0.002	
VP-6	86	0.002	
VP-7	57	0.001	
VP-8	2,278	0.052	
VP-9	578	0.013	
VP-10	2,406	0.055	
VP-11	487	0.011	
VP-12	1,885	0.043	
VP-13	1,544	0.035	
VP-14	95	0.002	
VP-15	99	0.002	
VP-16	352	0.008	
VP-17	324	0.007	
VP-18	706	0.016	
Subtotal	13,105	0.301	

SEASONAL WETLAND			
ID	SQ. FT.	ACRES	
SW-1	963	0.022	
SW-2	3,015	0.069	
SW-3	3,676	0.084	
SW-4	6,785	0.156	
SW-5	1,643	0.038	
SW-6	1,271	0.029	
SW-7	117	0.003	
SW-8	19,977	0.459	
SW-9	3,372	0.077	
SW-10	1,301	0.030	
SW-11	139	0.003	
SW-12	50	0.001	
SW-13	79	0.002	
SW-14	48	0.001	
SW-15	84	0.002	
SW-16	120	0.003	
SW-17	42	0.001	
SW-18	42	0.001	
SW-19	426	0.010	
SW-20	83	0.002	
Subtotal	42,089	0.966	

SEASONAL WETLAND SWALE			
ID	SQ. FT.	ACRES	
SWS-1	1,643	0.038	
SWS-2	2,406	0.055	
SWS-3	57,871	1.329	
SWS-4	48	0.001	
SWS-5	116	0.003	
SWS-6	600	0.014	
SWS-7	141	0.003	
SWS-8	78	0.002	
SWS-9	745	0.017	
SWS-10	387	0.009	
SWS-11	607	0.014	
SWS-12	313	0.007	
SWS-13	556	0.013	
SWS-14	662	0.015	
SWS-15	62	0.001	
SWS-16	377	0.009	
SWS-17	62	0.001	
SWS-18	301	0.007	
SWS-19	169	0.004	
SWS-20	1,385	0.046	
SWS-21	894	0.021	
SWS-22	539	0.012	
SWS-23	559	0.013	
Subtotal	71,222	1.633	

OTHER WATERS³

CREEK				
ID	SQ. FT.	ACRES	LINEAR FT.	
CREEK-1	154,908	3.556	3,529	
CREEK-2	113,623	2.608	2,100	
Subtotal	268,531	6.165	5,629	

WATERS OF THE U.S.

THREE CRITERIA SAMPLE POINT	GPS COORDINATES LAT/LONG
01	38.543007 / -121.138906
03	38.543007 / -121.138929
05	38.542824 / -121.138293
07	38.54120 / -121.138567
09	38.543399 / -121.134904
12	38.545562 / -121.138968

UPLAND

THREE CRITERIA SAMPLE POINT	GPS COORDINATES LAT/LONG
02N	38.542989 / -121.139308
04N	38.543042 / -121.138968
06N	38.542791 / -121.138221
08N	38.541232 / -121.138555
10N	38.543394 / -121.134814
11N	38.540650 / -121.133359
13N	38.545585 / -121.139599

NOTES

Gross Project Acreage: +/- 139 acres
Delineators: D. Snider, K. Walker, K. Kwan
Aerial Photo Source: USGS 2009
Topographic data: Derived from Airborne-1 Lidar Data
¹ Subject to U.S. Army Corps of Engineers verification. This exhibit depicts information and data produced in strict accord with the wetland delineation methods described in the 1987 Corps of Engineers Wetland Delineation Manual and the Regional Supplement to the Corps of Engineers Wetland Delineation Manual, Arid West Region and conforms to Sacramento District specifications. However, wetland boundaries have not been legally surveyed and may be subject to minor adjustments if exact locations are required.
² Boundary Source: The project boundary extents depicted on this graphic have been provided by WSA. This boundary is expected to be spatially precise to California requirements, but ECORP holds no liability to the accuracy of the boundary.
³ The acreage value for each feature has been rounded to the nearest 1/1000 decimal. Summation of these values may not equal the total potential Waters of the U.S. acreage reported.

WATERS OF THE U.S. ACREAGE¹

CLASSIFICATION	ACREAGE
WETLANDS:	
Vernal Pool	0.301
Seasonal Wetland	0.966
Seasonal Wetland Swale	1.633
OTHER WATERS:	
Creek	6.165
TOTAL:	9.064

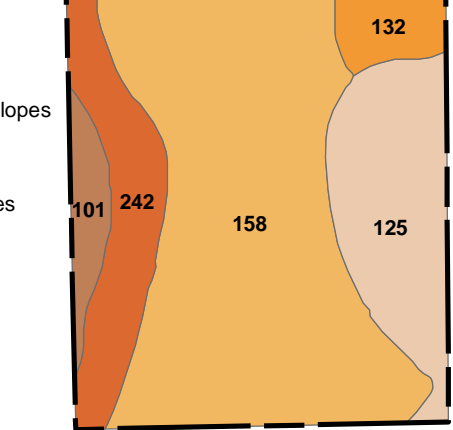
OTHER MAP FEATURES

- Three Criteria Sample Point
- Reference Coordinate
- Project Boundary²

NATURAL RESOURCES CONSERVATION SERVICE SOIL TYPES

Series Number - Series Name

- 101 - Amador-Gilender complex, 2 to 15 percent slopes
- 125 - Corning complex, 0 to 8 percent slopes
- 132 - Cheviot sandy loam, 0 to 3 percent slopes
- 158 - Hickville loam, 0 to 2 percent slopes, occasionally flooded
- 242 - Xerollevens, 0 to 2 percent slopes, flooded



Source: NRCS SSURGO Soils

VICINITY MAP



Figure 8. CARSON CREEK EAST

Wetland Delineation

Location: J:\GIS_Maps\2005-217_Corona_HW\Carson_Creek\Wetland_Mapping\Wetland_Delineation\CarsonCk_WD_v2.mxd
Production Date: 4/8/2014
Coordinate System: NAD 1983 StatePlane California II FIPS 4042 Feet
Scale: 1" = 100'
GIS Specialist: JDS



5.4.4 Carson Creek East Property

Between 2.25 and 4.50 acres of creation of Waters are proposed at the Carson Creek East Property. The proposed created Waters would be within the Carson Creek floodplain, and the acreage range corresponds to a 5% to 10% wetland density within creation areas. A preliminary site suitability report is included as Attachment D, and additional information is being gathered to develop a detailed creation plan for this site.

5.5 Hydrology, Topography, and Vegetation

5.5.1 Chester Drive Property

The Chester Drive Property sits at an elevation of approximately 90 feet above MSL, and consists primarily of a large vernal pool and adjacent pond. The on-site vernal pool is part of an approximately 150-acre vernal pool at the adjacent Bryte Ranch Mitigation Bank. The vernal pool is bisected by a berm with a large gated culvert. The site is northeast of a tributary of Laguna Creek. Surface water potentially exits the property from the southwest corner and flows to this tributary during wetter portions of the year. The site has less ponding than it did historically, which caused the dominant vegetation to shift from vernal pool endemics to non-native seasonal wetlands dominated by rye grass and Mediterranean barley in normal years. In mid-2012, the culvert located in the berm was removed to equalize water levels on either side of the berm. This should result in the re-establishment of vernal pool species such as coyote thistle (*Eryngium castrense*), slender popcorn flower, annual hairgrass (*Deschampsia danthonioides*), monkey flower (*Mimulus* sp.), wooly marbles (*Psilocarphus brevissimus*), rabbit's foot grass (*Polypogon monspeliensis*), and creeping spike rush (*Eleocharis palustris*) west of the berm (Gibson & Skordal 2012).

5.5.2 Shehadeh Property

The site is composed of generally flat to gently rolling terrain and is situated at an elevation of approximately 85 feet to 130 feet above MSL. Surrounding land uses include intensive agriculture to the northeast, east, and south and conservation areas to the northwest, west, and southwest. The site is divided by Laguna Creek which flows from east to west through the site. Vegetation surrounding Laguna creek includes willow thickets (*Salix* species), Valley oak (*Quercus lobata*), Himalayan blackberry (*Rubus armeniacus*), and cattail (*Typha* species). The northern and southern portions of the property are dominated by an annual grassland community with scattered ephemeral wetlands including vernal pools, seasonal wetlands, and seasonal wetland swales. The annual grassland community is dominated by non-native annual grasses including soft brome, wild oats, medusahead grass, and ryegrass. Other species occurring in the annual grassland include rose clover, hairy hawkbit, smooth cat's ear (*Hypochaeris glabra*), sticky tarweed, filaree, and cut-leaved geranium (ECORP 2012).

5.5.3 Carson Creek East Property

The site is composed of annual grasslands, seasonal wetlands, seasonal wetland swales, vernal pools, and two creeks with sparse riparian vegetation at an elevational range of approximately 125 feet to 175 feet above MSL. The majority of the site is comprised of annual grassland. The annual grassland portion of the site is dominated by mostly upland vegetation, including soft brome, filaree, black mustard

(*Brassica nigra*), yellow star-thistle, barbed goatgrass (*Aegilops triuncialis*), ryegrass, sticky tarweed and medusahead grass. The vernal pools on the site are dominated by Carter's buttercup, ryegrass, and Mediterranean barley. Other species included hairy hawkbit, Vasey's coyote thistle, and unidentified grasses. The seasonal wetland areas of the site are dominated by Baltic rush (*Juncus balticus*) and fiddle dock (*Rumex pulcher*). Trace species included woodland geranium (*Geranium molle*), spiny-fruit buttercup, and common dandelion (*Taraxacum officinale*). The seasonal wetland swales on the site are dominated by Mediterranean barley, hairy hawkbit, slender popcornflower, and Parish's spikerush (*Eleocharis parishii*), with small amounts of filaree, coyote thistle, Carter's buttercup, and flowering quillwort (*Triglochin scilloides*).

5.6 Soils

5.6.1 Chester Drive Property

According to the NRCS Soil Survey, two soil map units occur within the study area. The first unit is Galt clay, 0-2% slopes (152). This typic chromoxerert is moderately deep, moderately well drained, and possesses a calcareous hardpan that is weakly cemented with silica at a depth of approximately 32 inches. It contains inclusions of Clear Lake, Dierssen, and San Joaquin soils and urban land. The second map unit found within the study area is San Joaquin silt loam, 0-3% slopes (214). It is a moderately deep, moderately well drained soil with a 23-inch surface layer over a 5 inch claypan. Under this lies an 11 inch indurated hardpan situated above a 15-inch silica cemented hardpan. Surface water often pools after over-irrigation or heavy winter/spring rains. This unit also includes inclusions of Bruella, Galt, Hedge, and Kimball soils.

5.6.2 Shehadeh Property

According to the NRCS Soil Survey, five soil units or types have been mapped within the Shehadeh Property: Fiddymont Fine Sandy Loam, 1-8% slopes, Hedge Loam, 0-2% slopes, Redding Gravelly Loam, 0-8% slopes, San Joaquin Silt Loam, 0-3% slopes, and Xerarents-San Joaquin Complex, 0-1% slopes.

5.6.3 Carson Creek East Property

According to the NRCS Soil Survey, five soil units or types have been mapped within the Carson Creek East property: Amador-Gillender Complex, 2-15% slopes, Corning Complex, 0-8% slopes, Creviscreek Sandy Loam, 0-3% slopes, Hicksville Loam, 0-2% slopes, occasionally flooded, and Xerofluvents, 0-2% slopes, flooded.

5.7 Special-Status Species at the Mitigation Properties

5.7.1 Chester Drive Property

Surveys for vernal pool crustaceans were conducted during the 2011-2012 and 2012-2013 wet seasons, and vernal pool tadpole shrimp were observed on the site, as well as California linderiella (*Linderiella occidentalis*) (Gibson & Skordal 2012). Vernal pool fairy shrimp were not observed on the site, but have high potential to occur on the property since the vernal pool on-site is part of a larger vernal pool in the Bryte Ranch mitigation bank, where vernal pool fairy shrimp have been documented. Sacramento Orcutt grass has a known population 2.5 miles from the project, and slender Orcutt grass (*Orcuttia tenuis*) has

one occurrence less than one mile from the Property and another 1.3 miles from the Property (CDFW 2013).

5.7.2 Shehadeh Property

ECORP conducted dry-season surveys on the Shehadeh Property on 5 May 2013; both vernal pool fairy shrimp and vernal pool tadpole shrimp cysts were identified within the soil samples (ECORP 2013d). It is anticipated that all vernal pools and seasonal wetlands on the Property, as well as future-created vernal pools, will represent suitable habitat for these species. There are two occurrences of slender Orcutt grass approximately 1.5 miles southwest of the Property, and four occurrences of Sacramento Orcutt grass approximately five miles northeast of the Property. Special-status plant surveys have not been conducted on this Property to date (CDFW 2013).

5.7.3 Carson Creek East Property

Although special-status species surveys have not been conducted to date, presence of federally-listed species is not anticipated within the Carson Creek East Property due to a lack of suitable habitat. A large portion of this property is within the Carson Creek floodplain.

5.8 Historical, Present, and Proposed Uses

5.8.1 Chester Drive Property

Review of current aerial photographs of the Chester Drive Property indicates that the Project area may have been used historically for ranching or farming. A rectangular-shaped growth of trees is located on the southwestern portion of the Property around an artificial pond. There is also a constructed berm that bisects the vernal pool on-site, which may have been used historically for flood control. There is a culvert in this berm, now permanently open, which allows hydrological connectivity across the property as well as with a large vernal pool at the Bryte Ranch Conservation Bank. This berm is proposed for removal, which would result in the restoration of approximately 3.00 acres of vernal pool. In addition to adding additional vernal pool acreage to the property, removing the berm will result in the restoration of the historic ecological functions of the large vernal pool on both the Chester Drive and Byte Ranch Conservation Bank Properties. The property is proposed to be used as off-site mitigation for Waters of the U.S. and vernal pool crustaceans, and will be managed for the benefit of these resources. Management of the Chester Drive Property will increase the ecological functionality and value of the property and the restored vernal pool.

5.8.2 Shehadeh Property

A review of current aerial photographs of the Shehadeh Property indicates that the Project area may have been used historically for ranching or farming. Agricultural roads and fences outline the Project area along all sides. A dirt road enters through the northwestern corner of the Project Area and travels approximately 300 meters southeast where it terminates at what appear to be foundations or structural remains. The property is proposed to be used as off-site mitigation for Waters of the U.S. and vernal pool crustaceans and will be managed for the benefit of these resources.

5.8.3 Carson Creek East Property

The Carson Creek East property appears to be largely in its natural state. Adjacent land uses include livestock grazing and rural residences. The site is primarily influenced by Carson Creek, which bisects the property from north to south. The property is proposed to be used as off-site mitigation for Waters of the U.S. and will be managed for the benefit of these aquatic resources.

6.0 PROPOSED MITIGATION

Permittee-responsible compensatory mitigation is proposed on-site and at the Mitigation Properties (Chester Drive, Shehadeh, and Carson Creek East). This Proposal includes both preservation and restoration components and is intended to fulfill both the preservation and creation mitigation requirements for impacts to Waters of the U.S. and for impacts to federally-listed vernal pool crustacean habitat. Based on the USACE direction to provide mitigation within the MCA to the extent practicable, a mix of purchase of credits at Regulatory Agency-approved mitigation bank(s) or permittee-responsible mitigation at suitable properties in the vicinity of the proposed Project site is proposed. As there are not currently vernal pool creation credits available at Regulatory Agency-approved mitigation banks within the MCA, this Proposal relies heavily on permittee-responsible mitigation. It should be noted that the Project falls primarily within the Urban Development Area outlined in the South Sacramento County Habitat Conservation Plan (SSHCP). Timely completion and approval of the SSHCP may allow for the mitigation of the Project through the mechanisms established in the SSHCP. These mechanisms include payment of fees, acquisition of conservation easement(s), and/or acquisition of mitigation land(s) in fee title that are not presented in this Proposal. Therefore, the applicant reserves the right to fulfill all or parts of the Project's mitigation requirements using allowed SSHCP mechanisms should SSHCP approval and implementation occur.

6.1 Proposed Mitigation Phasing

Impacts and corresponding mitigation to Waters of the U.S., including those that are potential habitat for the vernal pool crustaceans, are proposed to be phased corresponding to the Project's anticipated development phasing (Figure 3). Table 7 describes the impacts to Waters of the U.S. that will occur during each phase.

Table 7. Impacts to Waters of the U.S. by Phase			
Waters	Impacts by Project Phase		
	<i>Phase 1</i>	<i>Phase 2</i>	<i>Preserve Area</i>
404* Avoided	0.000	0.000	11.600
404* Direct Impact	7.217*	9.923	1.339
404* Indirect Impact	0.000	0.001	0.377
ESA** Avoided (Credit)	0.004	0.000	29.860
ESA** Avoided (No Credit)	0.023	0.00	4.442
ESA** Direct Impact	21.523*	0.076	1.211
ESA** Indirect Impact	0.001	0.000	1.870
Grand Total	28.768*	10.000	50.699

* These numbers include 0.081 acres of vernal pool, 0.046 acres of seasonal wetland swale, 0.109 acre of creek/stream, 0.025 acres of seasonal impoundment, and 0.099 acre of roadside ditch for off-site road impacts.

A detailed mitigation phasing plan will be developed for approval by the Regulatory Agencies prior to each phase of Project construction.

6.2 Summary of All Mitigation

A total of 85.111 acres of Waters of the U.S. would be avoided within the on-site preserves and at the Mitigation Properties, which would be permanently preserved and managed for the benefit of these resources. Of the 85.111 acres of preservation, 56.169 acres represent habitat for the vernal pool

crustaceans, and 51.704 acres is considered credit towards mitigation obligations. The remaining 4.465 acres will be avoided, but are relatively close to Project development and therefore aren't being counted as mitigation credit. Mitigation for CWA compliance has been calculated at a minimum 1:1 mitigation-to-impact ratio for direct impacts. This ratio assumes that mitigation will occur in advance of Project impacts, such that a temporal loss of Waters of the U.S. will not occur. The acreage of fill requiring compensatory mitigation is 43.539 acres. A summary of all on-site and off-site preservation and creation is included in Table 8.

As the Project site will be preserving in perpetuity large amounts of Waters of the U.S., ECORP and the applicant have discussed with the USACE the potential to receive some "credit" towards the applicant's creation requirement for this preservation component. The USACE has indicated that this is a possibility, and for the purposes of this Proposal, it has been assumed that preservation of Waters of the U.S. will receive 1/6 credit towards creation obligations (i.e., for every 6.00 acres of preservation, creation obligations would be reduced by 1.00 acre).

Table 8. Waters of the U.S. to be Preserved/Avoided and Created On-Site and at the Mitigation Properties					
Wetland Type	Cordova Hills On-Site	Chester Drive	Shehadeh	Carson Creek East	Total
Preserved Listed Crustacean Habitat (Preserved(Credit))					
Vernal Pool	26.159	13.241	2.677	--	42.077
Seasonal Wetland	1.464	--	1.933	--	3.397
Seasonal Wetland Swale	1.730	--	3.990	--	5.720
Intermittent Drainage	0.475	--	--	--	0.475
Stock Pond	0.035	--	--	--	0.035
Total	29.863	13.241	8.600	--	51.704
Preserved Waters of the U.S. (Non-Habitat and Avoided (No-Credit) Habitat)					
Creek	0.174	--	--	6.165	6.339
Intermittent Drainage	10.101	--	0.832	--	10.933
Ephemeral Drainage	--	--	--	--	--
Perennial Creek	--	--	6.803	--	6.803
Ditch	--	--	--	--	--
Pond	--	0.612	--	--	0.612
Seasonal Wetland	0.181	--	--	0.966	1.147
Seasonal Wetland Swale	2.507	--	--	1.663	4.170
Vernal Pool	3.102	--	--	0.301	3.403
Total	16.065	0.612	7.635	9.095	33.407
Created Waters of the U.S.					
Constructed Waters	13.100	3.000	12.240	4.500	32.840
Total	13.100	3.000	12.240	4.500	32.840

6.3 In-Watershed Mitigation

Impacts and proposed mitigation for Waters of the U.S. (except vernal pools within the MCA) is detailed by watershed in Table 9. All mitigation for impacts to Waters of the U.S. (except vernal pools within the MCA, which will be mitigated for within the MCA) will be mitigated in-watershed. A discussion of vernal pool impacts and mitigation within the MCA is included in section 6.4. A combination of purchase of credits at Regulatory Agency-approved mitigation bank(s) or permittee-responsible mitigation at

suitable properties in the vicinity of the proposed Project site is proposed to accomplish mitigation requirements.

Table 9. Impacts and Proposed Creation/Creation Credit of Waters of the U.S. (Non-MCA Vernal Pool) by Watershed

	Impacts (Direct and Indirect)	Creation Provided						Creation to Impact Ratio
		Cordova Hills	Shehadeh	Chester Drive	Carson Creek	Bank Credits/ Permittee Responsible	Total	
Lower Sacramento	4.365	4.805*	2.706 *	2.309*	--	--	9.820*	2.25:1
Upper Consumnes	21.618	2.849*	--	--	6.011*	12.758	21.618*	1:1
Total	25.983	7.655*	2.706	2.309	6.011	12.758	31.438	1.21:1

* This number includes 1/6 Creation Credit for preserved Avoided/Preserved Waters of the U.S.

6.4 Mather Core Recovery Area

6.4.1 Vernal Pool Creation

There will be 16.701 acres of direct impacts to vernal pools within the MCA. Mitigation for vernal pool impacts within the MCA will occur entirely within the MCA. Vernal pool creation is proposed within the on-site Plateau Preserve within the MCA. One of the mitigation properties, the Shehadeh Property is located entirely within the MCA. Additionally, a portion of the 17.3 acre Chester Drive Property is located within the MCA (Figure 2). The majority (13.241 acres) of the Chester Drive Property consists of one large vernal pool, which is part of a much larger vernal pool on the Bryte Ranch Conservation Bank. While a portion of this vernal pool on the Chester Drive Property is bisected by a constructed berm, there is an existing culvert that allows connectivity across this berm. It is unclear why the MCA boundary bisects this vernal pool; however we believe it makes sense to receive MCA vernal pool preservation and creation credit at the Chester Drive Property. The Carson Creek East Property is not located within the MCA. Table 10 details the Project's on-site and off-site vernal pool impacts and creation within the Mather Core Area.

Table 10. Vernal Pool Impacts and Proposed Creation within Mather Core Area

Properties	Direct Impact	Creation Required (1:1)	Potential Creation in MCA
Cordova Hills	16.701*	16.701	Up to 13.100
Chester Drive	--	--	3.000
Shehadeh	--	--	12.240
Total		16.701	Up to 28.340**

* This number includes 0.081 acres of vernal pool within the off-site road improvements areas.

**Any additional creation necessary to achieve a 1:1 mitigation ratio is proposed to occur on-site within the Plateau Preserve at Cordova Hills. This includes any shortfall after creation/restoration has occurred at the Chester Drive and Shehadeh Properties, and allows the applicant some flexibility should creation be less than expected at these properties or if any wetland creation is not meeting success criteria. On-site creation may also be used to fulfill mitigation for impacts to non-vernal pool waters elsewhere in the Project area. Vernal pool creation resulting in an overall a mitigation ratio of greater than 1:1 is not anticipated at this time.

6.5 Vernal Pool Crustacean Habitat Preservation

A total of 22.658 acres of vernal pool crustacean habitat will be directly impacted, and 1.871 acres will be indirectly impacted by the Project. All direct and indirect impacts to vernal pool crustacean habitat will

occur within the MCA. The applicant proposes to mitigate for direct impacts to vernal pool brachiopod habitat within the MCA at a preservation ratio of 2.6:1. All Indirect impacts associated with the Project are proposed to be mitigated for at a ratio of 1:1 (preservation). Table 11 summarizes proposed habitat preservation ratios and acreage requirements and summarizes the proposed preservation occurring within the MCA at the on-site preserves and off-site Mitigation Properties. A combination of purchase of credits at Regulatory Agency-approved mitigation bank(s) or permittee-responsible mitigation at suitable properties in the vicinity of the proposed Project site is proposed to fulfill any preservation shortfall, or as otherwise determined during formal consultation with the USFWS.

Table 11. Vernal Pool Crustacean Habitat Impacts and Mitigation						
Properties	Direct Impact	Indirect Impact	Preservation Required for Direct Impacts (2.6:1)	Preservation Required for Indirect Impacts (1:1)	Preservation Secured	Current Surplus or Shortfall
Cordova Hills	22.810*	1.871	59.306	1.871	29.863	-
Chester Drive	--	--	--	--	13.241	-
Shehadeh	--	--	--	--	8.607	-
Total	22.810	1.871	59.306	1.871	51.711	-9.466
These numbers include 0.081 acres of vernal pool, 0.046 acres of seasonal wetland swale, and 0.025 acres of seasonal impoundment, for off-site road impacts.						

6.5.1 Presence of Vernal Pool Tadpole Shrimp and Vernal Pool Fairy Shrimp

Two of the three mitigation properties now support the federally-endangered vernal pool tadpole shrimp and federally-threatened vernal pool fairy shrimp. As the Cordova Hills property has also been documented to support both vernal pool tadpole shrimp and vernal pool fairy shrimp, it is important that the off-site mitigation sites also support these species to help facilitate their long-term survival and recovery. Chester Drive currently contains vernal pool tadpole shrimp and the Shehadeh property currently contains both vernal pool tadpole shrimp and vernal pool fairy shrimp. As described above in Section 3.5, as well as in Attachment A, vernal pool crustaceans are present at Cordova Hills, including within two of the on-site preserves. Table 11 summarizes the preservation of vernal pool crustacean habitat both within the on-site preserves and at the Mitigation Properties.

6.6 Proposal Goals

The goal of this Proposal is for the Project to result in no net loss of Waters of the U.S. as well as preservation of vernal pool crustacean habitat. The mitigation proposed within will benefit Sacramento County by increasing the local abundance of endemic plant species associated with local vernal pool ecosystems, by contributing to the survival and recovery of vernal pool species listed under FESA, including preservation within the MCA to the maximum extent practicable, and will result in no net loss of wetland habitat resulting from the implementation of the Project. Additionally, the Mitigation Properties will add to the adjacent regional open space preserves that exist currently as well as those that are planned due to implementation of the SSHCP, resulting in larger contiguous preserved areas.

6.6.1 Hydrology and Topography

The restoration/creation of Waters will be designed to have hydrology typical of similar Waters in the region. Direct precipitation and overland flows resulting from precipitation will make up the source of water for the wetlands.

6.6.2 Vegetation

Given that the wetlands will be designed to have hydrology typical of vernal pools, seasonal wetlands, and seasonal wetland swales in the Central Valley, the target plant species for the habitat is the typical suite of plants typically associated with these habitat types. The vernal pools are expected to be dominated by species such as slender popcorn-flower, Carter's buttercup, smooth goldfields, white-head navarretia, annual hairgrass, downingia (*Downingia* sp.), and Vasey's coyote-thistle. The seasonal wetlands are expected to be dominated by wetland generalist plant species that occur in the area such as Italian rye-grass, Mediterranean barley, rabbit's-foot grass, and cut-leaf geranium. The seasonal wetland swales are expected to be dominated by most of the same wetland generalist plants as the seasonal wetlands.

6.6.3 Wildlife Habitat

As a result of wetland restoration efforts, there will be an increase in wetland habitat at the Mitigation Properties. This in turn, will result in an increase in wintering waterfowl, shorebirds, invertebrates, and amphibians that utilize ephemeral wetlands. Wetland restoration may also result in an increase in vernal pool fairy shrimp, vernal pool tadpole shrimp, and Sacramento Orcutt grass habitat suitability and occurrences at the Mitigation Properties.

6.7 Rationale for Expecting Implementation Success

ECORP has successfully designed and overseen the establishment of numerous compensatory wetland mitigation projects in Sacramento and Placer Counties, including those in locations with similar attributes to the Mitigation Properties. This experience will be used in the design and restoration of the off-site Mitigation Properties. As wetland mitigation proposed at the Chester Drive Property consists of restoration to historic conditions, and will result in greater connectivity to a larger adjacent and highly functioning vernal pool, it has a high likelihood of success. The Applicant has retained the Institute for Ecohydrology Research to prepare detailed wetland creation plans for the Shehadeh and Carson Creek East Properties, as well as on-site creation within the Plateau Preserve. These wetland creation plans include detailed topographic and hydrologic data in order to determine not only where the placement of created wetlands is feasible, but also to ensure existing wetland hydrology is not negatively impacted. Detailed monitoring and success criteria will be developed for each site, as discussed below. One such plan has been completed to date and is included as Attachment B. The on-site preserves are protected from impacts by buffers and edge treatments along their borders.

6.8 Success Criteria and Monitoring

If the mitigation outlined in this Proposal is determined by the USACE to be acceptable, detailed Mitigation Monitoring Plans will be developed and sent to the USACE for coordination with other agencies, review, and approval. These Mitigation Monitoring Plans will include the specifics of the proposed wetland

restoration (e.g., construction plans), success monitoring methodology for the restored wetlands, performance criteria, adaptive management plans and annual reporting requirements.

Success criteria will comply with USACE Standard Operating Procedure for Uniform Performance Standards and focus on physical, hydrologic, faunal-diversity, and floral performance standards for depressional wetlands. These detailed criteria will be site-specific, and have not been completed to date.

6.9 Long-Term Management

Following wetland restoration efforts and the completion of the wetland success monitoring, all three of the Mitigation Properties as well as the on-site preserves will be managed in perpetuity as open space preserves in accordance with all requirements of the Regulatory Agencies, including the implementation of an agency-approved long term management plan, conservation easement, funding mechanism, and the assignment of a Preserve Manager. It is anticipated that a land-trust accredited non-profit manager (Sacramento Valley Conservancy or similar) or other organization deemed suitable by the Regulatory Agencies will serve as the Preserve Manager.

7.0 STATUS OF THE PROPOSED PLAN IN RELATION TO USACE MITIGATION REGULATION

This Conceptual Wetland Mitigation Proposal is being developed consistent with the USACE mitigation regulation at 33 CFR 3324(c). The final mitigation plan based on the USACE mitigation regulation will include the following elements. Under each element the current status is provided. All will be refined when the applicant submits the proposed final mitigation plan to the USACE for review and approval.

7.1 Objectives

Compensatory mitigation will be provided for impacts to vernal pools, seasonal wetlands, seasonal wetland swales, intermittent drainages, seeps, streams/creeks, ponds and ditches. A total of 85.079 acres of Waters of the U.S. would be avoided within the on-site preserves and at the Mitigation Properties, which would be permanently preserved and managed for the benefit of these resources. Of the 85.079 acres of preservation, 56.169 acres represent habitat for the vernal pool crustaceans, and 51.704 acres is considered credit towards mitigation obligations. The remaining 4.465 acres will be avoided, but are relatively close to Project development and therefore aren't being counted as mitigation credit. Mitigation for CWA compliance has been calculated at a minimum 1:1 mitigation-to- impact ratio for direct impacts. This ratio assumes that mitigation will occur in advance of Project impacts, such that a temporal loss of Waters of the U.S. will not occur. The acreage of fill requiring compensatory mitigation is 43.179 acres. The goal of this Proposal is for the Project to result in no net loss of Waters of the U.S. as well as preservation of vernal pool crustacean habitat. The mitigation proposed within will benefit Sacramento County by increasing the local abundance of endemic plant species associated with local vernal pool ecosystems, by contributing to the survival and recovery of vernal pool species listed under federal ESA, including preservation within the MCA to the maximum extent practicable, and will result in no net loss of wetland habitat resulting from the implementation of the Project. Additionally, the Mitigation Properties will add to the adjacent regional open space preserves that exist currently as well as those that are planned due to implementation of the SSHCP, resulting in larger contiguous preserved areas.

7.2 Site Selection

Mitigation site selection in this Proposal is based largely on the importance of in-watershed mitigation for the purposes of the USACE. The Project site is bisected by two 8-digit HUC watersheds the Lower Sacramento and the Upper Cosumnes. Proposed mitigation for impacts in each watershed is, to the extent practicable, located in the same watershed. Based on the high quality watershed data that has been developed for the Project site, ECORP was able to analyze Waters of the U.S. along the watershed "break" to determine with greater accuracy which Waters of the U.S. were attributed to which watersheds in actuality. Based on the USACE direction to provide mitigation within the MCA to the extent practicable, a mix of purchase of credits at Regulatory Agency-approved mitigation bank(s) or permittee-responsible mitigation at other suitable properties in the vicinity of the proposed Project site is proposed.

7.3 Site Protection Instrument

Site protection instruments will be developed when the final mitigation plan is submitted to the USACE for review and approval.

7.4 Baseline Information

Baseline information is presented in Section 3.5 above.

7.5 Determination of Credits

A complete description of how the proposed mitigation will provide the required compensation for unavoidable impacts to aquatic resources resulting from the permitted activity will be included in the applicant's final mitigation plan submitted to the USACE for review and approval. The principles used for this conceptual mitigation proposal related to mitigation for CWA compliance has been calculated at a minimum 1:1 compensatory mitigation-to-impact ratio for direct impacts. This ratio assumes that mitigation will occur in advance of Project impacts, such that a temporal loss of Waters of the U.S. will not occur. The applicant proposes to mitigate for direct impacts to vernal pool brachiopod habitat within the MCA at a preservation ratio of 2.6:1. All Indirect impacts to vernal pool brachiopods associated with the Project are proposed to be mitigated for at a ratio of 1:1 (preservation). The proposed mitigation is within the same HUC 8 watershed to the extent practicable, except for impacts to vernal pools within the MCA, which will be mitigated within the MCA. Moreover, the types of wetlands preserved and created are similar to those that will be impacted.

7.6 Mitigation Work Plan

Complete mitigation work plans will be developed for each mitigation site when the final mitigation plan is submitted to the USACE for review and approval. The mitigation work plan will provide information similar to what is identified in the attached Shehadeh Mitigation Plan. Geographic boundaries and other general information about each proposed mitigation site are provided above and in the enclosures.

7.7 Maintenance Plan

Complete maintenance plans will be developed for each mitigation site when the final mitigation plan is submitted to the USACE for review and approval.

7.8 Performance Standards

Complete performance standards will be developed for each mitigation site when the final mitigation plan is submitted to the USACE for review and approval.

7.9 Monitoring Requirements

Complete monitoring plans will be developed for each mitigation site when the final mitigation plan is submitted to the USACE for review and approval. The mitigation monitoring plan will include specifics of the proposed wetland restoration (e.g., construction plans), a success monitoring methodology for the restored wetlands, performance criteria, adaptive management plan and annual reporting requirements.

7.10 Long-term Management Plan

Complete long-term management plans will be developed for each mitigation site when the final mitigation plan is submitted to the USACE for review and approval. The plans will contain the information

identified in the May 2008 "Long Term Management Plan" template, developed by the USACE and the USFWS.

The approach to the long-term management of the sites' biological resources is to conduct annual site examinations and monitoring of selected characteristics to determine stability and ongoing trends of the preserved and created waters of the U.S., including wetlands, vernal pools, listed vernal pools crustacean species, and special status plant species. Annual monitoring will assess the sites' condition, degree of erosion, invasion of exotic or deleterious (e.g., thatch producing) species, water quality, fire hazard, and/or other aspects that may warrant management actions. While it is not anticipated that major management actions will be needed, an objective of this long-term management plan is to conduct monitoring to identify any issues that arise, and using adaptive management to determine what actions might be appropriate. Those chosen to accomplish monitoring responsibilities will have the knowledge, training, and experience to accomplish monitoring responsibilities.

7.11 Adaptive Management Plan

To the extent appropriate, adaptive management plans will be developed for mitigation sites when the final mitigation plan is submitted to the USACE for review and approval.

7.12 Financial Assurances

Financial assurance for components of the mitigation proposal will be identified, as appropriate, in the final mitigation plan submitted to the USACE for review and approval.

7.13 Other Information

Other information will be included, as appropriate, in the final mitigation plan submitted to the USACE for review and approval.

8.0 REFERENCES

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LIST OF ATTACHMENTS

Attachment A – On-Site Wetland Preservation Analysis for Cordova Hills

Attachment B – Vernal Pool Mitigation and Monitoring Plan for the Shehadeh Property

Attachment C – Vernal Pool Mitigation and Monitoring Plan for the Shehadeh Property

Attachment D – Site Evaluation, Hydrological Potential, and Conceptual Onsite Seasonal and
Vernal Pool Wetland Creation Opportunities for the Carson Creek Property

ATTACHMENT A

On-Site Wetland Preservation Analysis for Cordova Hills

On-Site Wetland Preservation Analysis

For

Cordova Hills

Sacramento County, California

(USACE # SPK-2004-116, USFWS # TBD)

October 2014

Prepared For:
Cordova Hills, LLC



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- Attachment A – Cordova Hills Edge Treatments
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1.0 INTRODUCTION

The overarching goal of the proposed Cordova Hills Project (Project) is to provide a master-planned community to serve the greater Sacramento region. The Project will minimize and mitigate for its impacts on biologically sensitive natural resources through a combination of on-site and off-site preserves. The purpose of this document is to provide:

- 1) A description of the on-site preserves within the Project;
- 2) A rationale for determining which aquatic features within the Project site have been considered federally listed species habitat;
- 3) A justification for the Project's on-site preservation credit of Waters of the U.S. (Waters) and federally listed species habitat; and
- 4) A description of anticipated indirect effects to Waters and federally listed species habitat.

The intent of this analysis is to provide information in support of the Project's Clean Water Act section 404 Individual Permit application with the U.S. Army Corps of Engineers (USACE # SPK-2004-116), and to support consultation with the U.S. Fish and Wildlife Service under section 7 of the federal Endangered Species Act. It is important to note that Cordova Hills, LLC. (Applicant) is committed to adhering to the South Sacramento County Habitat Conservation Plan's (SSHCP; in development) "hard line" preserve map within the Project site in an effort to contribute to the regional conservation of wetland complexes, other Waters, and the federally listed species within these areas.

1.1 *Project Location*

The Project site is located east of Grant Line Road, north of Kiefer Road, south of Glory Lane and west of Carson Creek (Figure 1. *Project Location and Vicinity*). The overall Project site corresponds to portions of Sections 13, 14, 23, and 24 of Township 8 North and Range 7 East [Mount Diablo Base Meridian (MDBM)] and Section 18 of Township 8 North and Range 8 East (MDBM) of the "Buffalo Creek, California" 7.5-minute quadrangle (U.S. Department of the Interior, Geological Survey, 1980). The approximate center of the project is located at 38° 32' 30" North and 121° 10' 30" West within the Lower Deer Creek Watershed (#180400130503, U.S. Department of Interior, Geological Survey 1978) (Figure 2. *Cordova Hills Watersheds*).

1.2 *Project Description and Background*

The approximately 2,688-acre Project consists of a mixture of planned land uses. The Project will include approximately 1,000 gross acres of residential uses ranging in density from one dwelling unit per net acre to forty units per net acre, with an overall average net residential density of ten dwelling units per acre. The Project may also contain a senior housing component. In addition, the Project will include approximately 1.38 million square feet of retail and commercial space, and a university/college campus center situated on approximately 240 acres. The university/college campus center will be designed to provide a residential learning environment, with sufficient capacity to provide on-campus housing to the majority of the approximately 6,000 students anticipated upon build out. In addition to the university/college campus center, the Project will accommodate the growing educational facility needs of the region by providing sites for the development of future elementary and secondary schools. The retail, commercial, institutional and residential uses are planned for various locations

throughout the Project, including a unique "Town Center" which will be located in the western portion of the Project, adjacent to the Plateau Preserve.

The Project includes approximately 687 acres of open space, parks, preserves, and agricultural areas. Approximately 538 acres will be preserved to protect Waters of the U.S. and federally listed and other special-status species, and these areas will be protected and managed in perpetuity for the benefit of these resources. Project design took into account existing terrain and drainage patterns, and includes Low Impact Development (LID) design concepts (outlined in the Project's Specific Plan Area Master Plan, which has been adopted by Sacramento County), as well as extensive edge treatments, which include a combination of trails, drainage swales, and native and/or drought tolerant landscaping to buffer the on-site preserves from the long-term effects of development. The preserve edge treatments are described in more detail in Section 5.0.

There are four proposed on-site preserves: 1) the 401.7-acre Plateau Preserve; 2) the 93.6-acre Central Drainage Preserve; 3) the 18.4-acre University Preserve; and 4) the 45.3-acre Carson Creek Preserve (Figure 3. *Wetland Preserves, Edge Treatments & Impacts*), which are described in further detail in Section 3.0 below. As described above, it is important to note that the Applicant has changed the proposed land plan from the original "Preferred Alternative" to the "Regional Conservation Alternative" outlined in the SSHCP following the submittal of the original 404 permit application. This modification was made to support the goals and objectives of this regional conservation strategy. While this change did not result in significant overall land use changes, the configuration of the Plateau Preserve has changed, which has resulted in direct impacts to slightly more acres of Waters of the U.S. However, this re-configuration of the Plateau Preserve has become more inclusive of the watersheds and linear drainages connecting the Project to adjacent properties and potential future preserves to the west. Plateau preserve configurations for each land plan are shown in Figure 4. *Preferred Alternative vs. Regional Conservation Alternative*.

2.0 EXISTING SITE CONDITIONS

2.1 General Conditions

The Project site is generally comprised of level to steeply rolling topography, and is situated at elevations ranging from 130 to 278 feet above mean sea level (MSL). The western portion of the site is a relatively expansive plateau supporting a number of vernal pool complexes at an approximate average elevation of 245 feet above MSL. The central portion of the site is comprised of an unnamed intermittent drainage that is tributary to Deer Creek, referred to as the central drainage, which bisects the Project and drains from north to south. The eastern portion of the site is occupied by a series of gently rolling hills, with Carson Creek situated along the eastern boundary. The site supports an annual grassland community that is interspersed with complexes of ephemeral wetlands (i.e., vernal pools, seasonal wetlands, and seasonal wetland swales) and intermittent drainages.

The greater Project site has historically, and is currently (2014) being used as rangeland for livestock grazing. Surrounding current land uses include rural residences, roadways, a landfill, and livestock operations. Residential development is approved directly to the west and a proposed development (SunCreek) is located generally to the southwest.

2.2 Waters of the U.S.

A total of 89.107 acres of Waters of the U.S. have been delineated within the Project site, including: vernal pools, seasonal wetlands, seasonal impoundments, seasonal wetland swales, seep, freshwater marshes, intermittent drainages, man-made stock ponds, and creek (also called streams/creeks by the SSHCP) (ECORP 2007a) (Figure 5. *Wetland Delineation and Watershed Analysis*).

2.3 Federally Listed Species

2.3.1 Plants

Special-status plant surveys were conducted throughout the Cordova Hills Project site by ECORP Consulting, Inc. (ECORP) biologists in accordance with the USFWS *Guidelines for Conducting and Reporting Botanical Inventories for Federally Listed, Proposed and Candidate Plants* (USFWS 2000, ECORP 2007b, ECORP 2008). Sacramento Orcutt grass (*Orcuttia viscida*) was the only federally listed plant species observed, and has been documented within two vernal pool complexes that are located within the northeastern corner of the Plateau Preserve (Figures 6f and 6g, *On-Site Avoidance, Preservation, and Indirect Impact Detail*). There will be a minimum avoidance buffer of 300 feet where possible around each of these vernal pools to reduce indirect effects from construction activities (the project boundary interferes with the extent of this buffer to the north and west). This buffer, in conjunction with the edge treatments (discussed in Section 3.0 below), is anticipated to fully preserve these populations of Sacramento Orcutt grass. As such, indirect impacts to Sacramento Orcutt grass are not anticipated. Because the Plateau Preserve will be protected and managed in perpetuity for the benefit of vernal pools and the endemic species within, and will result in a large, contiguous preserve area, the Sacramento Orcutt grass population will persist and may occupy additional preserved vernal pools in the future.

2.3.2 Vernal Pool Branchiopods

Assessment-level wet-season large branchiopod surveys (ECORP 2013a) were conducted between 2 January and 4 February 2013 by ECORP biologists. These surveys targeted the federally listed as threatened vernal pool fairy shrimp (*Branchinecta lynchi*) and endangered vernal pool tadpole shrimp (*Lepidurus packardii*). During surveys, approximately 50% of all depressional wetlands (vernal pools and seasonal wetlands) and 95% of ephemeral and intermittent drainages within the entire Project site were surveyed once. Of the 944 features surveyed, listed branchiopods were only found in approximately 10% (95) of the features.

During the wet-season surveys, listed vernal pool branchiopods were identified within a total of 89 wetlands and other Waters on the western plateau. These occurrences account for 94% of all the branchiopod occurrences on the entire project site. Topography east and south of the western plateau becomes much steeper, and as such the aquatic habitat becomes linear and hydrologically episodic ("flashy"). The only known occurrences outside of the western plateau are six occurrences of vernal pool fairy shrimp, which are located in depressional wetlands on the west side of the central drainage. These occurrences may not persist long-term due to flooding of the central drainage, and are likely re-colonized due to runoff from the western plateau during heavy rain events.

In addition to the 2012-2013 wet season surveys, 41 vernal pools and seasonal wetlands east of the western plateau were subsequently targeted for guideline-level dry-season surveys during the summer of 2013 (ECORP 2013b). These wetlands were selected, in consultation with Mr. Terry Adelsbach (Senior Biologist) of the U.S. Fish and Wildlife Service, because they appeared to provide the highest quality habitat for listed vernal pool branchiopods east of the western plateau. No evidence of federally listed branchiopods (carapaces or cysts) was identified during these targeted dry-season surveys. Known vernal pool branchiopod occurrences on the Project site are included in Figures 6a-6d, 6f-6i, and 6k-6n.

3.0 ON-SITE PRESERVES

There are four proposed on-site preserves: 1) the Plateau Preserve, 2) the Central Drainage Preserve, 3) the University Preserve, and 4) the Carson Creek Preserve (Figure 4), which are described in further detail below.

3.1 Plateau Preserve

The Project site is characterized by a large, undulating, relatively flat plateau on the western edge, which contains the majority (66%) of the Project site's vernal pools, as well as both of the Sacramento Orcutt grass populations (ECORP 2007b, ECORP 2008) and nearly all (94%) of the vernal pool branchiopod occurrences (ECORP 2013a). This portion of the project site will contain the largest preserve, the 401.7-acre Plateau Preserve. While the on-site preserves have been sited to reduce impacts to waters of the U.S., a particular emphasis has been placed on the Plateau Preserve due to its extensive biological resources. The edge treatments around this preserve were sited to reduce effects to the waters of the U.S. within.

The Plateau Preserve lies on the western plateau of the Project site, and is important because it contains the highest number and density of vernal pools, and represents the highest quality habitat within the Project site for the federally listed vernal pool fairy shrimp, vernal pool tadpole shrimp, and Sacramento Orcutt grass. The western plateau differs from the remainder of the Project site, as it consists of a single geologic unit (the Laguna Formation), is relatively flat with gently rolling topography, falls within the Laguna Creek Watershed (a distinct watershed from the rest of the Project site, see Figure 2.), and contains vernal pools and swales with a high degree of hydrological connectivity. Overall, the western plateau is significantly unique from the rest of the Cordova Hills Project site. The Mather Core Area (MCA), as described in the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (Recovery Plan, USFWS 2005), has been targeted as an important vernal pool preservation zone by the USACE and the USFWS, and a portion of the MCA encompasses the western side of the Project site. Based on existing resources within the Project site, there is evidence that the authors of the Recovery Plan may have intended for the eastern edge of the western plateau to serve as the boundary of the MCA. Attachment B, *Refinements to the Mather Core Area at Cordova Hills*, has been prepared to further support this position, and a summary of the unique physical and biological characteristics of the western plateau are included below.

3.1.1 Hydrologic Connectivity

The Plateau Preserve is located within the Laguna Creek watershed, which flows to the Sacramento River, while the remainder of the Project site is in the Carson Creek and Deer Creek watersheds, which flow to the Cosumnes River (Figure 2).

3.1.2 Biological Resources

In 2009, ECORP conducted a California Rapid Assessment Method (CRAM) analysis of a subset of wetlands at the Project Site in order to determine their relative habitat quality values (ECORP 2009). A total of 24 Assessment Areas (AA) were identified, and the AAs that received the highest scores were located on the western plateau. The average CRAM score by AA on the western plateau was 84.7, while the average score for the remaining AAs was 72.8, further supporting the fact that the resources on the western plateau are of relatively high ecological value. A map of the CRAM analysis results and a more detailed discussion are included in Attachment B.

As discussed in Section 2.4.1 above, 94% of all listed branchiopod occurrences and all Sacramento Orcutt grass occurrences on the Project site are located on the Western Plateau. This further supports the assertion that the vernal pools and other Waters on the Western Plateau are of higher biological value than the remainder of the site.

3.1.3 Soils

The Plateau Preserve is comprised exclusively of one geologic unit – the Laguna Formation, which is the oldest alluvial-deposited surface in the Central Valley (CNPS 2009). The remaining geologic units on-site are Mehrten Formation, Valley Springs Formation, Lower Modesto Formation, and Gopher Ridge Volcanics. The Mehrten Formation is derived from volcanic mudflow deposits, the Valley Springs Formation is derived from volcanic ash flow deposits, the Lower Modesto Formation is comprised of recent alluvial deposits, and the Gopher Ridge Volcanics are comprised of metamorphic rocks. Although there are a few pockets of Laguna Formation on the Project site east of the western plateau, the majority of the formation corresponds with the watershed break at the eastern edge of the western plateau as discussed above. The Laguna Formation is well known for supporting high quality vernal pools.

3.2 *Central Drainage and University Preserves*

To the east and south of the western plateau, elevation drops off steeply, and existing Waters are mostly steep and flashy intermittent drainages. Topography again begins to flatten toward the center of the Project site, where the 93.6-acre Central Drainage and 18.4-acre University Preserves are located. These preserves have been configured to encompass the highly incised intermittent “central drainage,” as well as the majority of adjacent swales, drainages, and depressional wetlands in order to maintain the integrity of the central drainage system. This linear preserve will also allow for wildlife connectivity north and south of the Project site. The University Preserve consists of approximately 18.4 acres, and is essentially a continuation of the Central Drainage Preserve. Portions of this preserve lie south of the proposed university, and may be used as an ecological study area in conjunction with the University’s educational curriculum.

3.3 *Carson Creek Preserve*

To the east of the central drainage, the Project site begins to gain elevation, and becomes a series of rolling hills until its eastern edge. In this area, the topography begins to flatten toward Carson Creek to the east. This area contains the 45.3-acre Carson Creek Preserve, a portion of which abuts the approximately 139-acre off-site Carson Creek East Property, which will be protected in perpetuity by Cordova Hills, LLC under a conservation easement for the purposes of preservation of Waters and Swainson's hawk habitat as mitigation for this Project. This off-site property will also contain a pedestrian trail, which will connect to a planned future regional trail system. The addition of this 139-acre off-site parcel will result in an interconnected 184.3-acre block of habitat preservation along Carson Creek.

4.0 **FRAMEWORK FOR AVOIDANCE, PRESERVATION, AND IMPACT ANALYSIS**

On-site preservation potential and indirect impacts were assessed for all wetlands and other Waters within the on-site preserves based on whether they serve as habitat for federally listed species and are regulated by both the Endangered Species Act and section 404 of the Clean Water Act, or do not serve as habitat and are anticipated to be regulated by only section 404 of the Clean Water Act. All Waters within the Plateau Preserve and a subset of Waters west of the central drainage represent potentially suitable habitat for the vernal pool fairy shrimp and vernal pool tadpole shrimp. Additionally, and as discussed above, all known occurrences of Sacramento Orcutt grass on-site are located within the Plateau Preserve.

A description and rationale for preservation and impact analysis under each regulatory framework are described below, and shown graphically for all wetlands and other Waters within the Project site in Figures 6a-6s.

4.1 *Endangered Species Act—Federally Listed Species*

Initially, wetlands that serve as habitat for federally listed vernal pool species were placed into one of the following four impact categories based on distance from preserve edge: 1) directly impacted; 2) indirectly impacted (will not be filled, but may be subject to altered hydrology and or other effects in the future due to Project build-out based on watershed reduction and/or distance from development); 3) avoided (no credit); and 4) avoided (credit). Waters classified as "avoided (no credit)" are not expected to be subject to indirect effects during or after Project buildout, but are not expected to count as on-site preservation credit for the purposes of mitigation, and those classified as "avoided (credit)" are expected to receive on-site preservation credit. Subsequently, wetlands were re-categorized based on field visits, feedback from Mr. Terry Adelsbach (Senior Biologist) of the U.S. Fish and Wildlife Service during meetings throughout 2012 and 2013, and a desktop assessment of site conditions (watershed limits, flow paths, topography). Ultimately, nearly every individual wetland and other Water that serves as habitat for federally listed species has been classified individually based on the categories described above (Figures 6a-6k).

4.2 *Clean Water Act—Waters of the U.S.*

Based on topography and inundation characteristics, as well as a lack of listed species occurrences, wetlands and other Waters east of the central drainage (i.e., preserved within the

Carson Creek Preserve) are not considered to be habitat for federally listed species, and therefore were assessed differently from those within and west of the central drainage. No federally listed plants were identified east of the Central Drainage Preserve during focused surveys, and assessment level wet and dry season surveys failed to detect vernal pool crustaceans. While edge treatments will still be utilized around preserve edges, a minimum 50-foot buffer from Project development was used to assess indirect impacts under the Clean Water Act. This is displayed graphically in Figures 6p-6s. Based on the linear nature of most of the Waters (and associated watersheds) within the Carson Creek Preserve, it is anticipated that a buffer of this size will adequately preserve the character and function of these Waters. Waters that do not represent potentially suitable habitat for federally listed vernal pool species have been classified into three categories: 1) directly impacted; 2) indirectly impacted; and 3) avoided.

5.0 EDGE TREATMENTS

The Project is designed to limit direct and indirect impacts to wetlands and other Waters within the four on-site preserves. The incorporation of edge treatments, variations of which are detailed in Attachment A, *Cordova Hills Edge Treatments*, will provide a substantial transition zone buffer to the on-site preserves from adjacent build-out (Figure 4), which will greatly limit indirect impacts. Edge treatments are defined as the physical edge conditions surrounding all preserve edges. In general, edge treatments will provide at minimum an additional 50-foot buffer to all preserve areas, although the edge treatments are greater than 50 feet where project design allows, and the Central Drainage Preserve will have an approximately 100-foot buffer. Buffer sizes vary based on the specific edge area and its characteristics (watersheds, gradients, and land use type). These buffers are located outside of the preserve boundaries proper, and consist of open space, trails, drainage corridors, hydrological barriers (swales), native straw seeding, irrigated and non-irrigated landscaping, Parks, detention basins, and fencing.

Various edge treatment designs have been developed specific to certain areas throughout the Project; however, all on-site preserves will be buffered by the most naturalized edge treatment design to minimize the effects of development and maximize the long-term functionality of the Waters and other natural resources within the preserves. All preserve edge treatments will include a drainage swale, an 8-foot naturalized area planted with native straw seeding, a pedestrian trail, and a second drainage swale. Drainage swales will function as a hydrological barrier between urban runoff/nuisance flows and the preserves. The landscaped area would be located on the development side of the edge treatment area, and serve as an additional buffer, further decreasing potential "edge effects" to wildlife and habitat.

6.0 ON-SITE AVOIDANCE, PRESERVATION, AND INDIRECT IMPACTS

6.1 Plateau Preserve

The Plateau Preserve was designed to preserve as many waters of the U.S. as practicable, and extra consideration was given to the placement and sizes of the edge treatment areas in order to minimize indirect effects. The western plateau is a unique area on the Project site due to its relatively flat topography, which drops off steeply on the eastern edge (Figures 6f-6h). Because of the interconnected nature of the Waters on the plateau, ECORP analyzed the watersheds of

the Waters that fall within the preserve to determine which features will maintain most or all of their watersheds following project construction, and which features may be subject to potential indirect effects. The edge treatment areas will be subject to grading during construction, but the end result will primarily be naturalized grassland with a pedestrian trail and drainage swales to ensure that extra irrigation water from surrounding land uses will not affect the hydrology and inundation regime of the preserved wetlands. Figures 6a-6i show the edges of the Plateau Preserve, including the placement of the additional edge treatment, as well as the existing watersheds and flow directions for wetlands and swales on-site.

The eastern edge of the plateau drops sharply in elevation at the edge of the preserve boundary, as can be seen in the "hillshade" and "flow directions" shown in Figure 6f-6h. The eastern edge of the plateau corresponds very closely with this topographic break, and it is anticipated that none of the wetlands within that portion of the preserve will be impacted following Project construction due to this significant hydrological break and the minimum 50-foot edge treatments.

Topographic changes were not as pronounced on the western edge of the Plateau Preserve. The preserve boundary and edge treatments in these areas attempt to capture large areas of watersheds where possible, and the Project's edge treatment design will serve as a naturalized buffer along the preserve edge (Figures 6a-6e).

The southern edge of the Plateau Preserve did not offer a clean topographic break between development and preserve. Some of the watersheds of the avoided wetlands in this portion of the Plateau Preserve are relatively long and linear, and extend roughly from north to south. Because of this, some of the avoided wetlands have been placed in the "indirect impacts" category due to reductions in watershed size and the general flow direction of south to north (from development to preserve). These areas can be seen in Figures 6d-6e and 6h-6i. Land uses adjacent to the western and southern edges of the Plateau Preserve will consist primarily of mixed-use development.

The northern edge of the Plateau Preserve is bordered by an existing partially-paved road (Glory Lane), and there is one residential parcel located near the center of the northern edge of the Preserve. This parcel contains some light agricultural uses, and it appears that it contributes irrigation or other runoff in the preserve. The proposed project will not change the land use in this area, and it is anticipated that the wetlands within this portion of the preserve will continue to function the way they are currently. Because the baseline conditions in this area are not expected to change as a result of Project implementation, many of these features have been placed in the "avoided (credit)" category. Figures 6a and 6f detail these portions of the Plateau Preserve.

6.2 Central Drainage and University Preserves

The Central Drainage, a tributary to Deer Creek, is located at the lowest elevation on the Project site. There are significant slopes both east and west of the central drainage, and it has a large overall watershed. Because of this, the watersheds for individual wetlands in this portion of the site tend to be large, and are generally long, linear, and relatively steep. Development of the project will necessitate the collection of excess stormwater runoff (magnified by an increase in impermeable surfaces), and this water will be captured in a series

of detention basins on either side of the Central Drainage Preserve (these basins will be located within the edge treatment rather than the on-site preserve). The basins will be designed such that they percolate water down to the water table during periods of low to moderate flow, and will spill into the central drainage during large storm events. The basins will be designed to dry within 2-3 days following rain events, and discharges will be released below the restrictive layer. Because of the storage and discharge design of these detention basins, water capture and storage is not expected to affect surrounding wetlands, and excess water (primarily due to irrigation and a reduction in permeable surfaces) will be discharged into the central drainage, which will also reduce potential effects to adjacent preserved wetlands. It is anticipated that the central drainage itself will retain its existing inundation pattern and hydrological function.

The Central Drainage and University Preserves have been designed to preserve the existing hydrology of the large central drainage and adjacent swales, other drainages, and depressional wetlands in order to preserve the hydrological and habitat connectivity north and south of the Cordova Hills Project site. Due to the narrow nature of the central drainage, the Central Drainage and University Preserves are also relatively narrow. Because of this, 100 feet of edge treatment have been provided along the majority of the Central Drainage Preserve (design constraints limit this 100-foot width in some locations) and it is anticipated that this additional buffer will protect preserved depressional wetlands from adverse effects resulting from Project development. The University Preserve abuts the edge of the Project site, which is not currently planned for development. Because these preserves contain such extensive buffers, and because the Project has been designed to capture stormwater runoff for storage and eventual release into the central drainage proper, all depressional wetlands within these preserves that will not be directly affected by Project construction and are considered avoided (Figures 6j-6o).

6.3 Carson Creek Preserve

While the Carson Creek Preserve appears rather small and disconnected within the Project site, the Applicant also controls a property immediately east of a portion of the Carson Creek Preserve (Figure 4), and has committed to recording a conservation easement over this adjacent Property (the Carson Creek East property). While the specifics of said conservation easement are not currently known, the Applicant will retain the ability to use this property for the purposes of mitigation for the loss of agricultural lands, Swainson's hawk habitat, open space, and/or Waters of the U.S. associated with the Cordova Hills Project.

The Carson Creek Preserve was designed to preserve the linear, relatively steep drainages located in this portion of the Project site. Based on the topography of the area, it is anticipated that the preserved Waters in the Carson Creek Preserve will maintain their character and continue to function as contributory drainages into Carson Creek and adjacent water bodies. These preserves, along with the adjacent Carson Creek East property, will contribute to the extensive habitat corridor located along Carson Creek (Figures 6p-6s).

7.0 CONCLUSION

The Applicant has made every effort to preserve as many Waters of the U.S. as practicable while still meeting Project objectives. By adopting the Regional Conservation Alternative boundary for the Plateau Preserve, the majority of high quality vernal pool complexes, listed branchiopod occurrences, and all known Sacramento Orcutt grass occurrences will be preserved

in perpetuity and managed for the benefit of the vernal pool complexes within. Additionally, the Applicant has gone to great lengths to develop edge treatments along all preserve areas that will significantly reduce the potential for indirect impacts from adjacent development. The Central Drainage Preserve and the University Preserve have not only been designed to protect the character and functionality of the drainage within, but will also result in a north-to-south habitat connectivity corridor that bisects the entire Project site. The Carson Creek Preserve has been sited to protect the steep, linear drainages that are tributary to Carson Creek. The Carson Creek Preserve, along with the Carson Creek East property, will contribute to the extensive habitat available along the Carson Creek corridor. Overall, each preserve and associated edge treatment placement have been designed, in consultation with the USFWS, to minimize impacts to wetlands and other Waters, in particular those that represent habitat for federally listed species, preserve the natural resources of the area, and contribute to the overall conservation goals of the region.

Of the total 89.107 acres of Waters on-site, 58.857 acres have been classified as habitat for federally listed large branchiopods, and 29.863 acres (51%) are expected to receive on-site preservation credit from the USFWS. An additional 4.465 acres will be preserved but may not receive on-site preservation credit due to their proximity to development, and 1.871 acres will be avoided but may be subject to indirect effects. Overall, only 38% of potential listed branchiopod habitat will be directly affected by the Cordova Hills Project. The Project will directly impact 18.272 acres, indirectly impact 0.378 acres, and avoid 11.600 acres of Waters that are not habitat for listed branchiopods but are regulated under section 404 of the Clean Water Act. All avoidance and impact classifications are summarized by preserve and shown graphically in Figures 6a-6s.

8.0 REFERENCES

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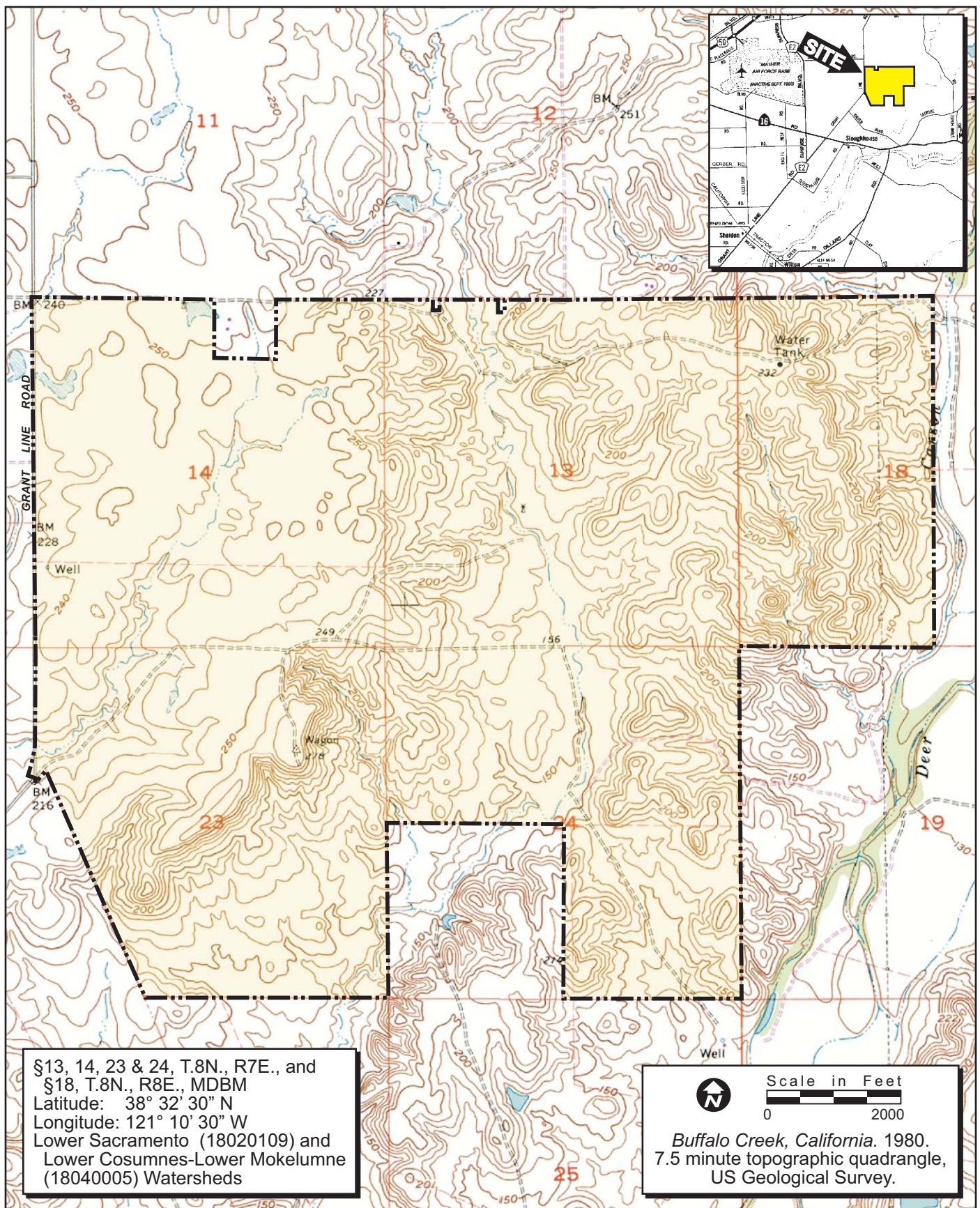


Figure 1. Project Location and Vicinity

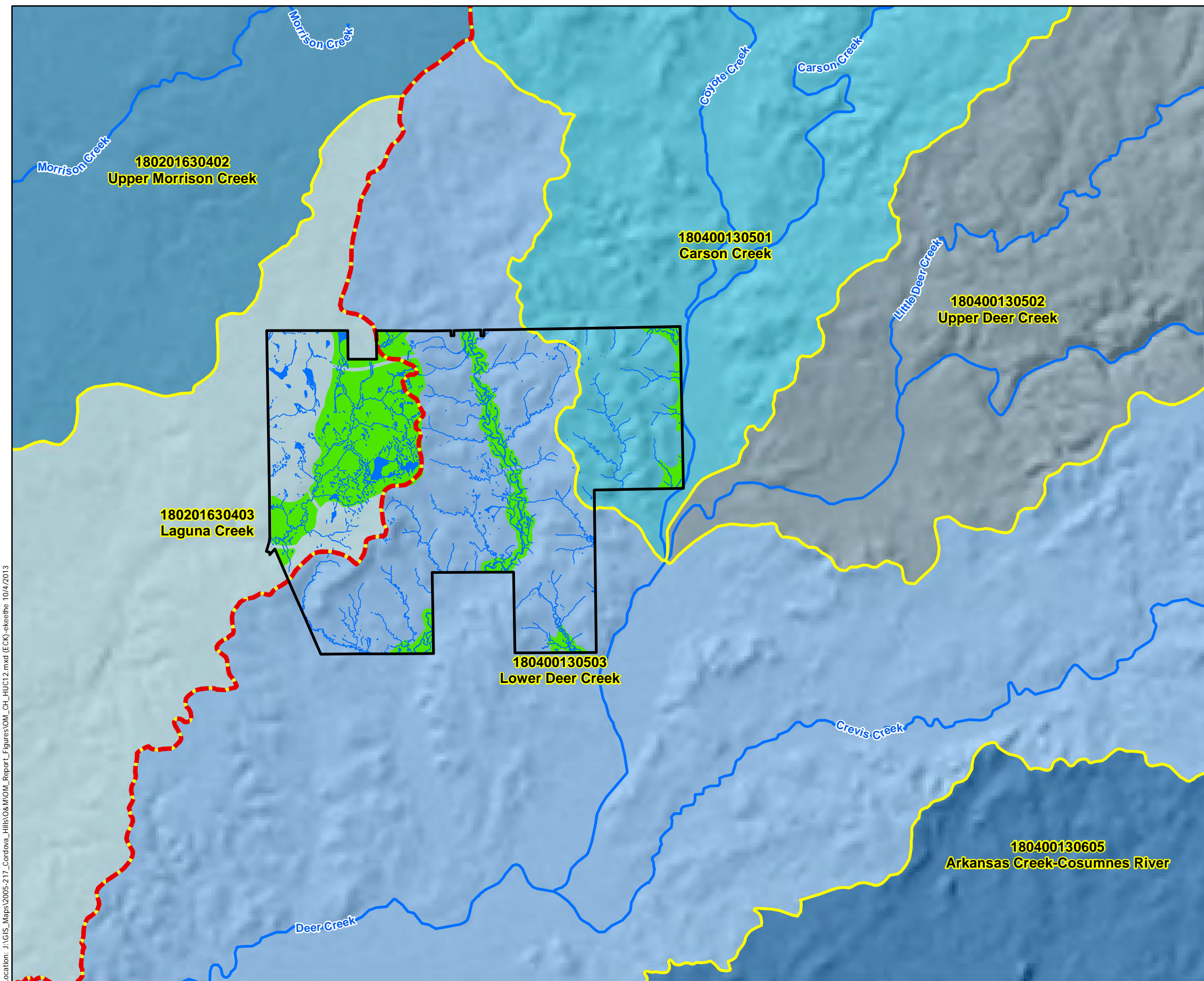


Figure 2.
Cordova Hills Watersheds

Map Features

-  Project Boundary
-  Preserve
-  Project Wetlands
-  HUC 06 Watershed Boundary
-  HUC 12 Watershed Boundary

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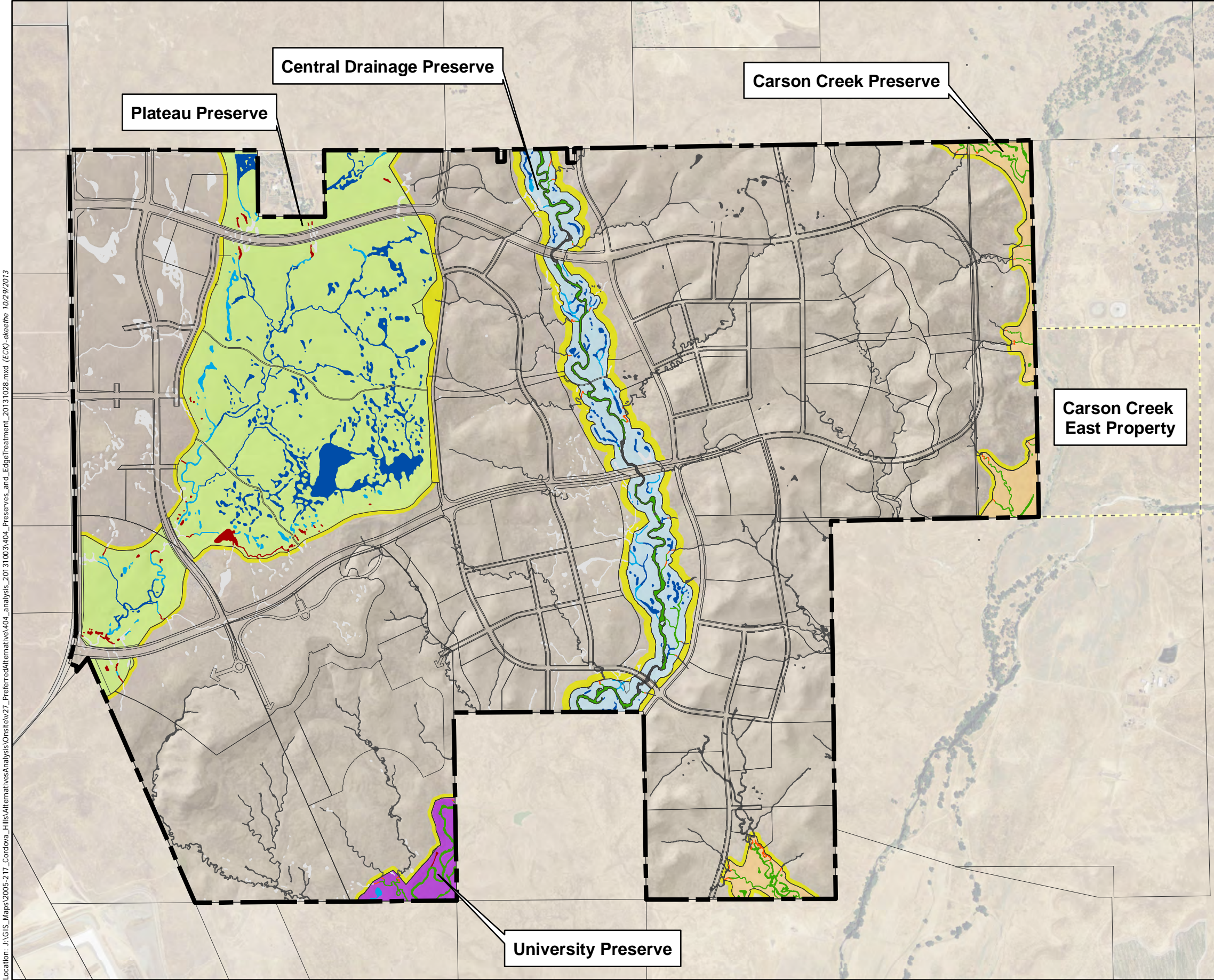


Figure 3.
Wetland Preserves,
Edge Treatments & Impacts

Map Features

- Project Boundary
- Edge Treatment (R2)³
- Land Use
- Preserve Area**
 - Plateau (401.7 ac.)
 - Central Drainage (93.6 ac.)
 - Carson Creek (45.3 ac.)
 - University (18.4 ac.)

404 Wetland Impacts¹

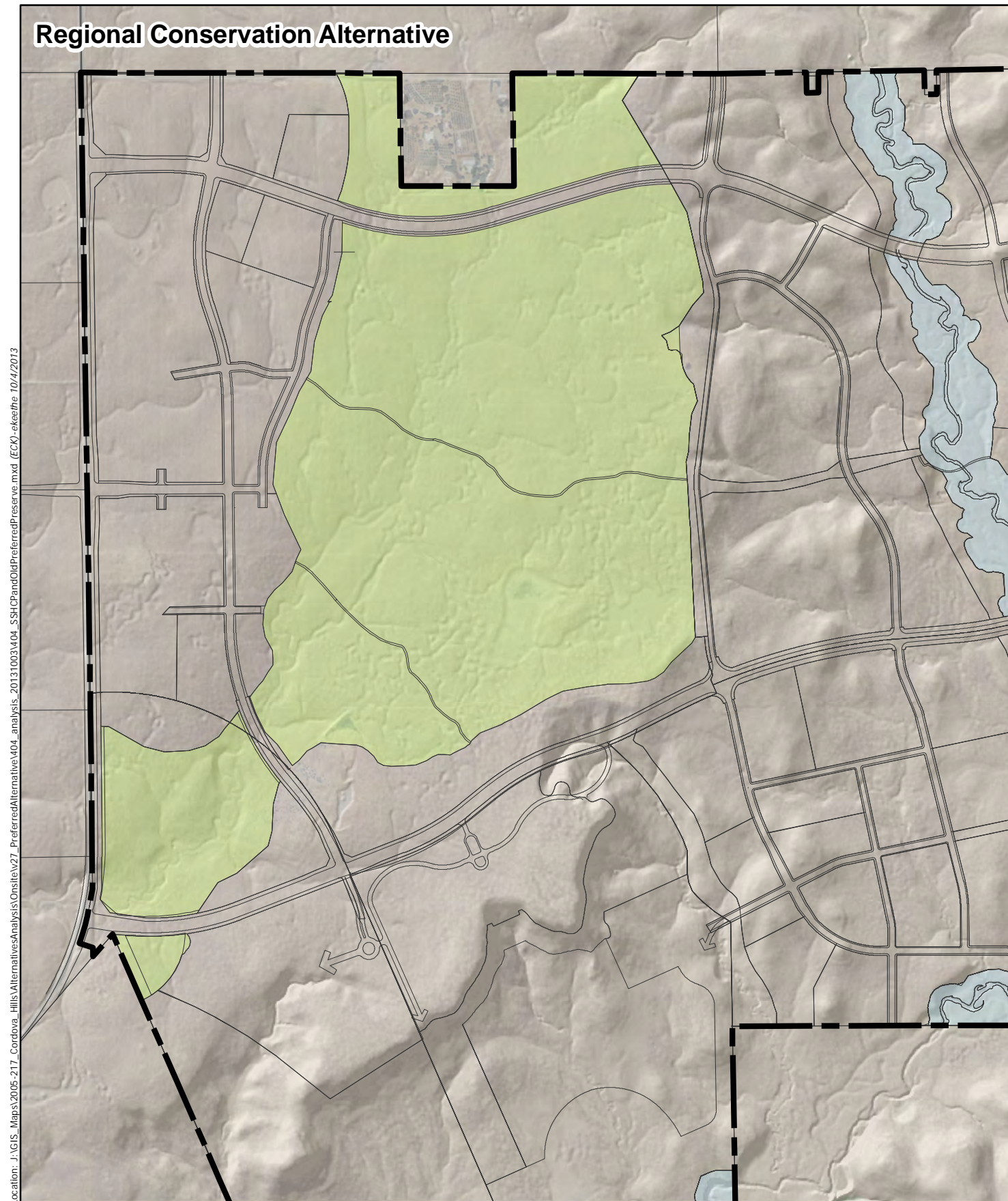
- Avoided
- Indirect Impact
- Direct Impact

ESA Wetland Impacts²

- Avoided (Credit)
- Avoided (No Credit)
- Indirect Impact
- Direct Impact

Wetland Impact by Shrimp Habitat and Wetland Type	Grand Total
404 Avoided	11.600
Creek	0.174
Intermittent Drainage	9.360
Seasonal Wetland	0.106
Seasonal Wetland Swale	1.431
Vernal Pool	0.530
404 Direct Impact	18.272
Intermittent Drainage	5.769
Seasonal Wetland	0.656
Seasonal Wetland Swale	10.373
Seep	0.012
Vernal Pool	1.462
404 Indirect Impact	0.378
Intermittent Drainage	0.119
Seasonal Wetland Swale	0.249
Vernal Pool	0.010
ESA Avoided (Credit)	29.863
Intermittent Drainage	0.475
Seasonal Wetland	1.464
Seasonal Wetland Swale	1.730
Stock Pond	0.035
Vernal Pool	26.159
ESA Avoided (No Credit)	4.465
Intermittent Drainage	0.741
Seasonal Wetland	0.075
Seasonal Wetland Swale	1.076
Vernal Pool	2.572
ESA Direct Impact	22.658
Intermittent Drainage	0.341
Seasonal Wetland	2.303
Seasonal Wetland Swale	3.125
Stock Pond	0.688
Vernal Pool	16.201
ESA Indirect Impact	1.871
Intermittent Drainage	0.094
Seasonal Wetland	0.167
Seasonal Wetland Swale	0.236
Stock Pond	0.799
Vernal Pool	0.575
Grand Total	89.107

- 1 - Non-Branchiopod Habitat Wetlands within 50 feet of Preserve edge are considered Indirectly Impacted
- 2 - All Non Directly Impacted Depressional Features within Central Drainage are Classified as Avoided.
- 3 - Edge Treatment consists of 50 ft. exterior addition to all preserve areas, except for the Central Drainage, which has a 100 ft. buffer except where this would encroach upon planned development areas.



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Map Date: 10/4/2013
Photo Source: NAIP 2012

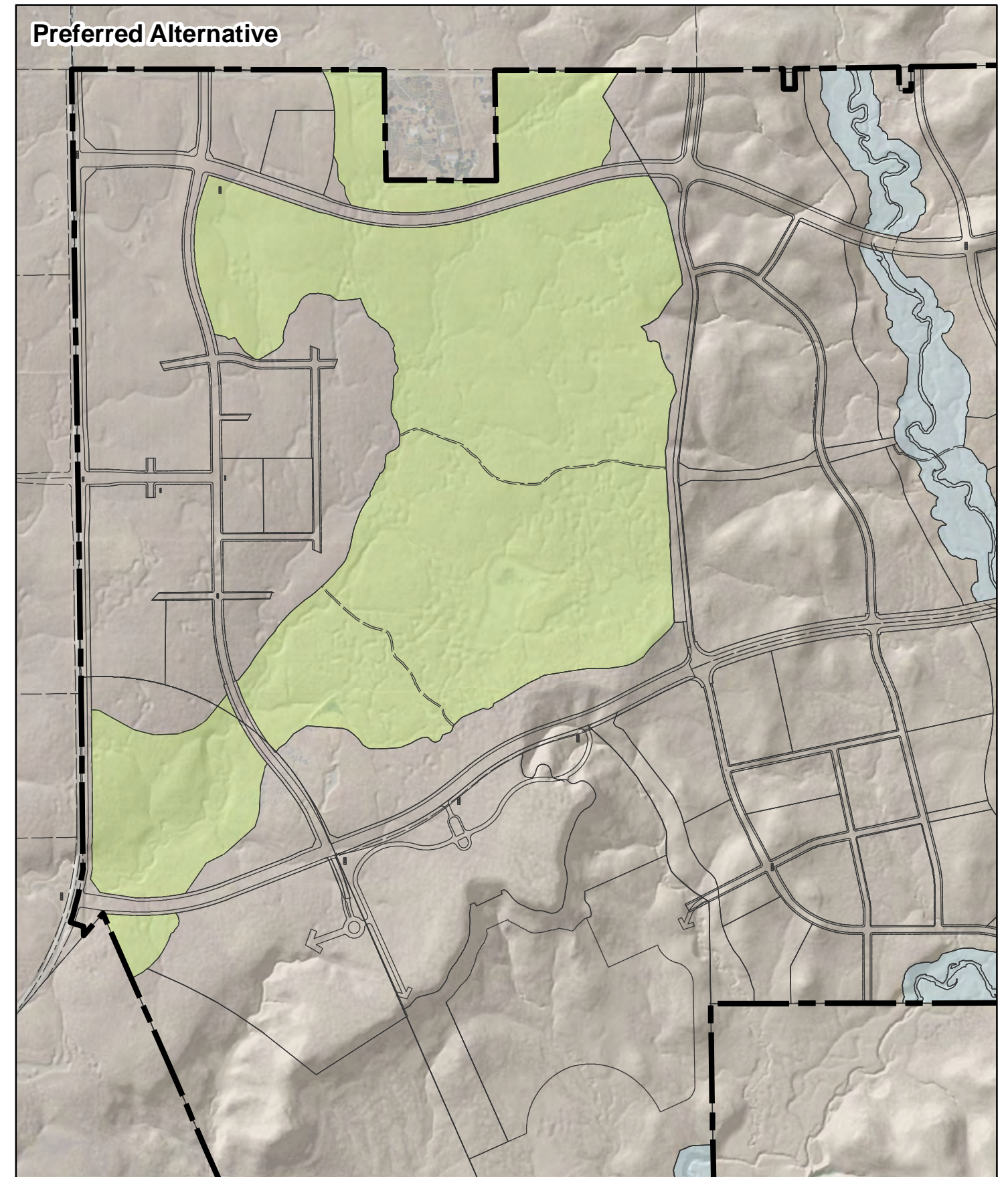


Figure 4. Preferred Alternative vs. Regional Conservation Alternative

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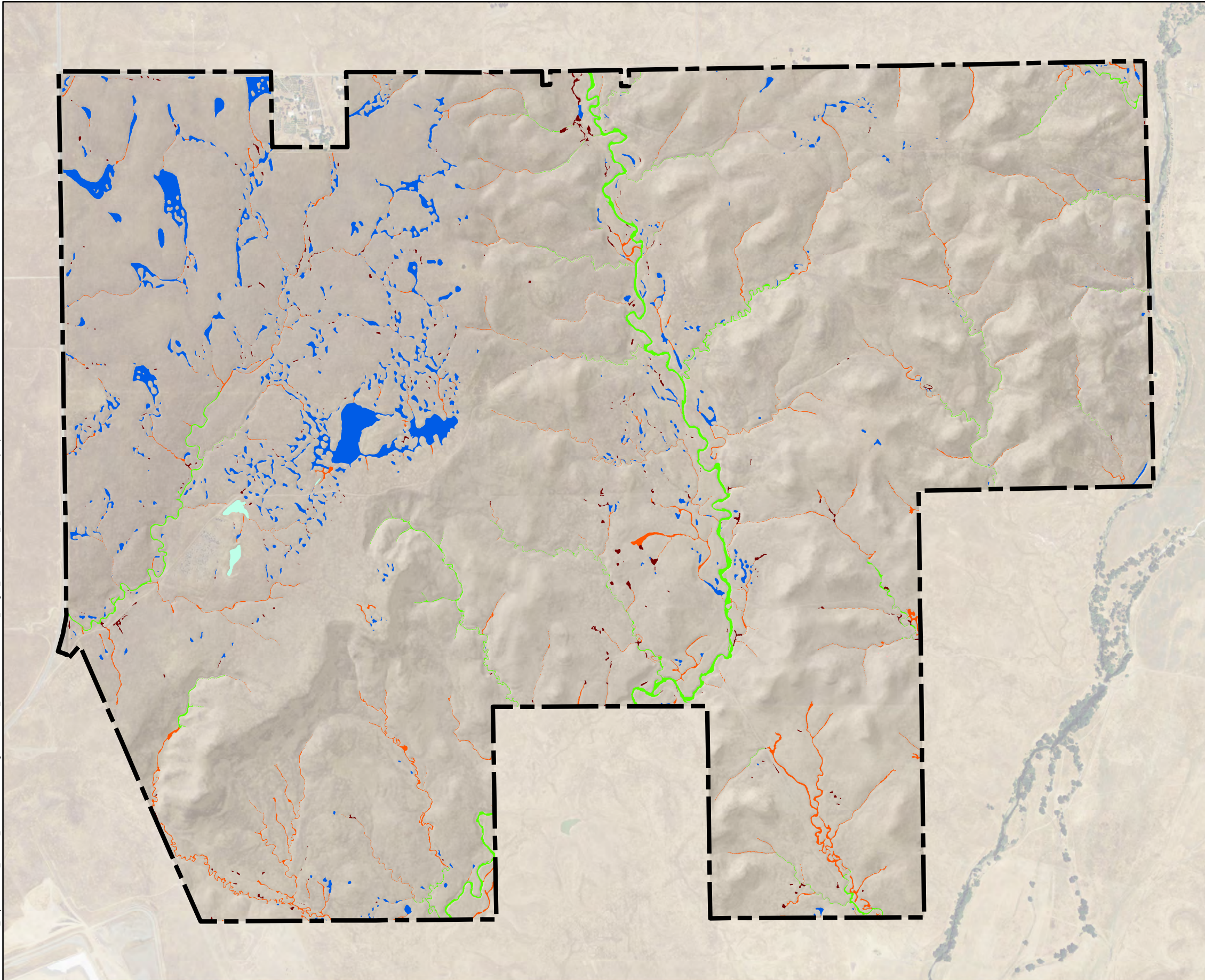




Figure 5.
Wetland Delineation


Map Features

 Project Boundary

Wetland Features

 Vernal Pool

 Seasonal Wetland

 Seasonal Wetland Swale

 Seep

 Intermittent Drainage

 Creek

 Stock Pond



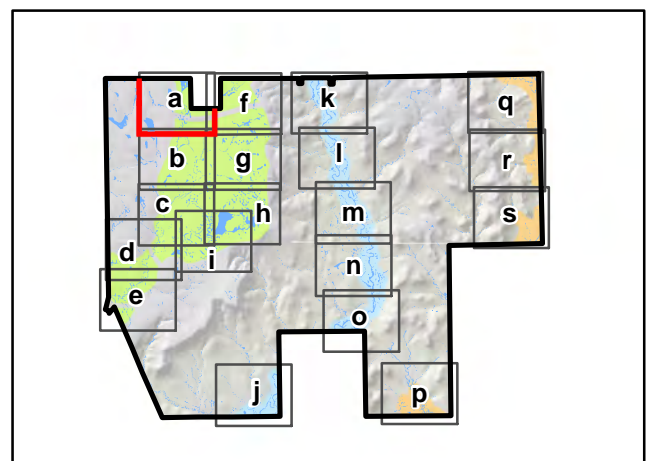


Figure 6a
On-Site Avoidance, Preservation
and Indirect Impact Detail

Map Features

-
- Project Boundary**  **DEM Derived Flowlines**
- Preserve Area**  **Land Use**
-  **Plateau**  **Edge Treatment (R2)³**
-  **Central Drainage**  **Feature Watersheds**
-  **Carson Creek**
- Survey Results**
-  **University**  **Branchinecta lynchi**
- 404 Wetland Impacts¹**  **Lepidurus packardii**
-  **Avoided**  **Sacramento Orcutt Grass**
-  **Indirect Impact**
-  **Direct Impact**
- ESA Wetland Impacts²**
-  **Avoided (Credit)**
-  **Avoided (No Credit)**
-  **Indirect Impact**
-  **Direct Impact**

- 1 - Non-Branchiopod Habitat Wetlands within 50 feet of Preserve edge are considered Indirectly Impacted
- 2 - All Non Directly Impacted Depressional Features within Central Drainage are Classified as Avoided.
- 3 - Edge Treatment consists of 50 ft. exterior addition to all preserve areas, except for the Central Drainage, which has a 100 ft. buffer except where this would encroach upon planned development areas.



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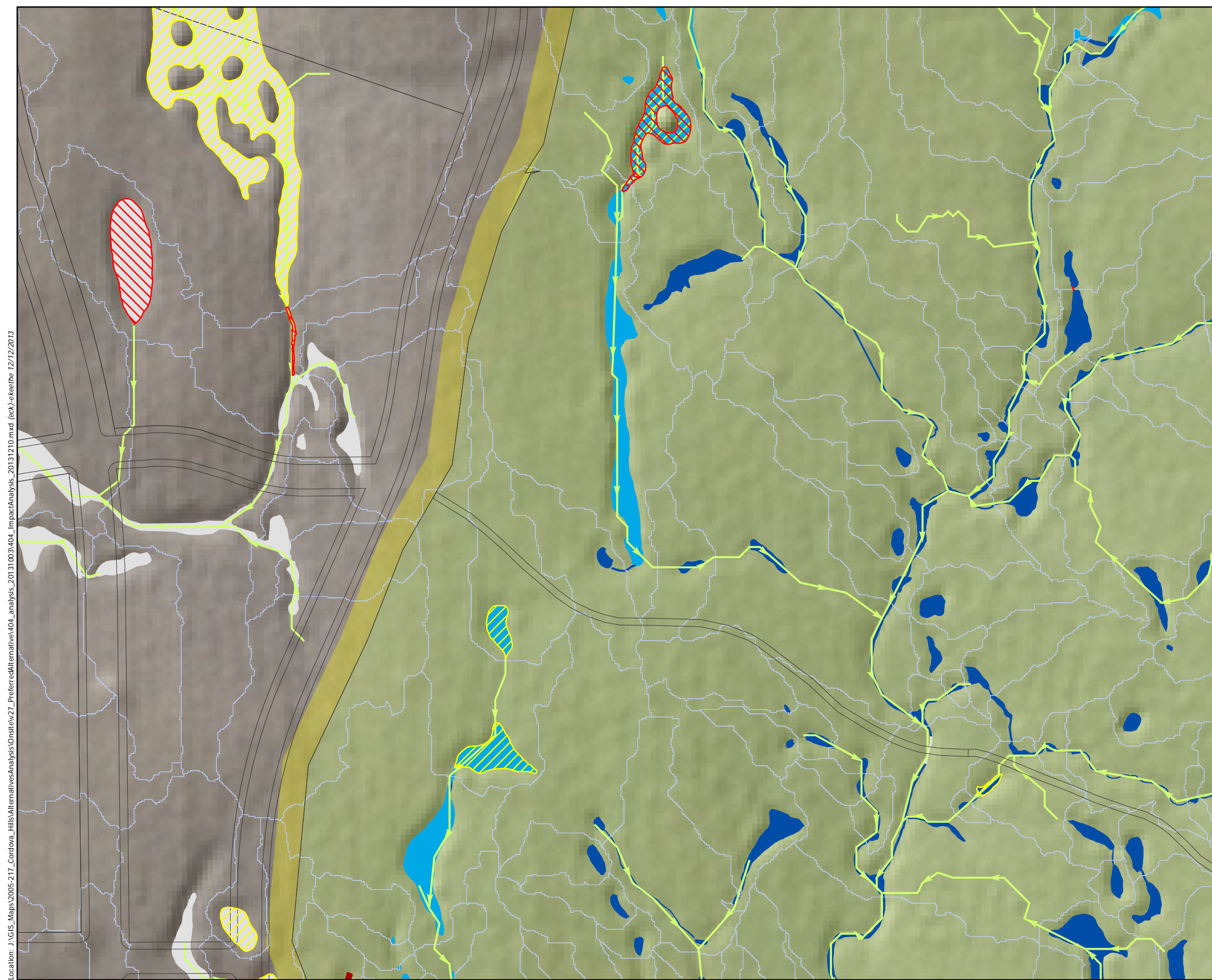


Figure 6b On-Site Avoidance, Preservation and Indirect Impact Detail

Map Features

Project Boundary	DEM Derived Flowlines
Preserve Area	Land Use
Plateau	Edge Treatment (R2)³
Central Drainage	Feature Watersheds
Carson Creek	Survey Results
University	Branchinecta lynchi
404 Wetland Impacts¹	Lepidurus packardii
Avoided	Sacramento Orcutt Grass
Indirect Impact	
Direct Impact	
ESA Wetland Impacts²	
Avoided (Credit)	
Avoided (No Credit)	
Indirect Impact	
Direct Impact	

1 - Non-Branchiopod Habitat Wetlands within 50 feet of Preserve edge are considered Indirectly Impacted
2 - All Non Directly Impacted Depressional Features within Central Drainage are Classified as Avoided.
3 - Edge Treatment consists of 50 ft. exterior addition to all preserve areas, except for the Central Drainage, which has a 100 ft. buffer except where this would encroach upon planned development areas.

The inset map shows a larger geographic area with a grid of letters (a-s) indicating different regions. A red box highlights the specific area shown in the main map, located in the central-left portion of the grid.

ECORP Consulting, Inc.
ENVIRONMENTAL CONSULTANTS

Map Date: 12/12/2013

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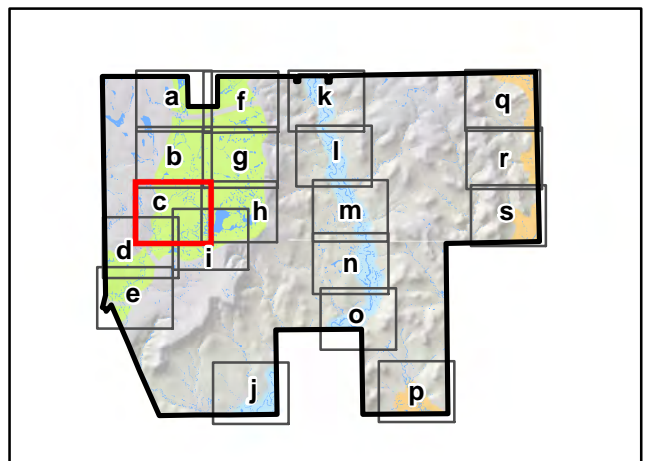


Figure 6c
On-Site Avoidance, Preservation
and Indirect Impact Detail

Map Features

- Project Boundary
- DEM Derived Flowlines
- Preserve Area**
- Plateau
 - Central Drainage
 - Carson Creek
 - University
- 404 Wetland Impacts¹**
- Avoided
 - Indirect Impact
 - Direct Impact
- ESA Wetland Impacts²**
- Avoided (Credit)
 - Avoided (No Credit)
 - Indirect Impact
 - Direct Impact
- Edge Treatment (R2)³**
- Edge Treatment (R2)³
- Feature Watersheds**
- Feature Watersheds
- Survey Results**
- Branchinecta lynchi
 - Lepidurus packardii
 - Sacramento Orcutt Grass

- 1 - Non-Branchiopod Habitat Wetlands within 50 feet of Preserve edge are considered Indirectly Impacted
- 2 - All Non Directly Impacted Depressional Features within Central Drainage are Classified as Avoided.
- 3 - Edge Treatment consists of 50 ft. exterior addition to all preserve areas, except for the Central Drainage, which has a 100 ft. buffer except where this would encroach upon planned development areas.



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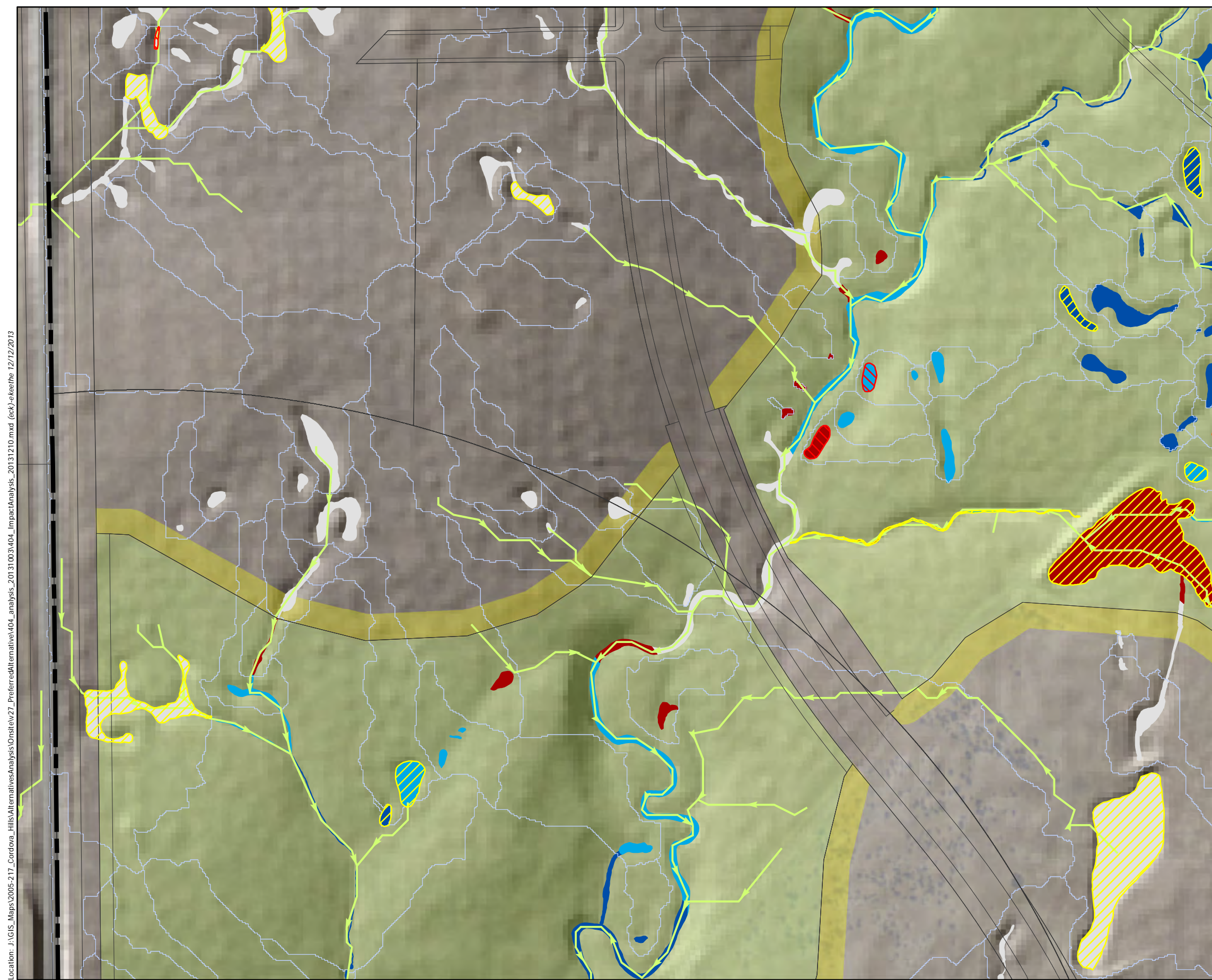
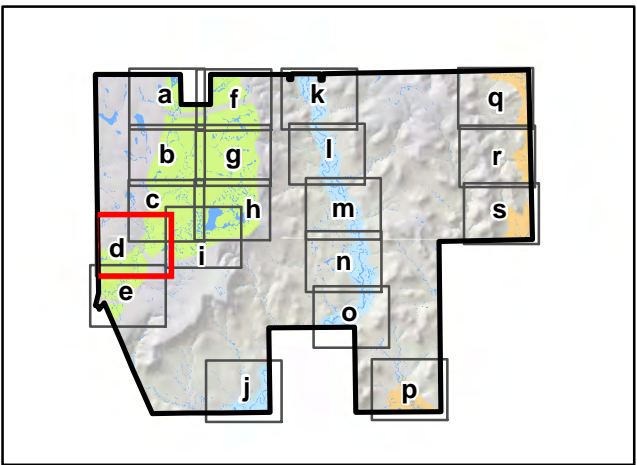


Figure 6d
On-Site Avoidance, Preservation
and Indirect Impact Detail

Map Features

- Project Boundary
- DEM Derived Flowlines
- Land Use
- Preserve Area**
 - Plateau
 - Central Drainage
 - Carson Creek
 - University
- Edge Treatment (R2)³
- Feature Watersheds
- Survey Results**
 - Branchinecta lynchi
 - Lepidurus packardii
 - Sacramento Orcutt Grass
- 404 Wetland Impacts¹**
 - Avoided
 - Indirect Impact
 - Direct Impact
- ESA Wetland Impacts²**
 - Avoided (Credit)
 - Avoided (No Credit)
 - Indirect Impact
 - Direct Impact

1 - Non-Branchiopod Habitat Wetlands within 50 feet of Preserve edge are considered Indirectly Impacted
2 - All Non Directly Impacted Depressional Features within Central Drainage are Classified as Avoided.
3 - Edge Treatment consists of 50 ft. exterior addition to all preserve areas, except for the Central Drainage, which has a 100 ft. buffer except where this would encroach upon planned development areas.



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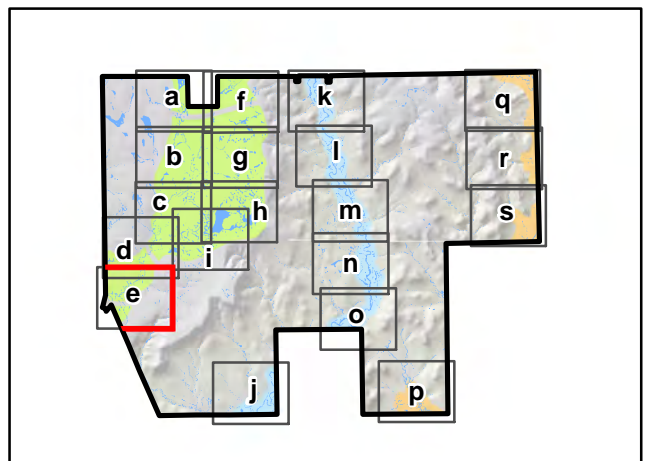


Figure 6e
On-Site Avoidance, Preservation
and Indirect Impact Detail

Map Features

- | | |
|-----------------------------|-------------------------|
| Project Boundary | DEM Derived Flowlines |
| Preserve Area | |
| Plateau | Edge Treatment (R2)³ |
| Central Drainage | Feature Watersheds |
| Carson Creek | Survey Results |
| University | Branchinecta lynchi |
| 404 Wetland Impacts¹ | Lepidurus packardii |
| Avoided | Sacramento Orcutt Grass |
| Indirect Impact | |
| Direct Impact | |
| ESA Wetland Impacts² | |
| Avoided (Credit) | |
| Avoided (No Credit) | |
| Indirect Impact | |
| Direct Impact | |

- 1 - Non-Branchiopod Habitat Wetlands within 50 feet of Preserve edge are considered Indirectly Impacted
- 2 - All Non Directly Impacted Depressional Features within Central Drainage are Classified as Avoided.
- 3 - Edge Treatment consists of 50 ft. exterior addition to all preserve areas, except for the Central Drainage, which has a 100 ft. buffer except where this would encroach upon planned development areas.



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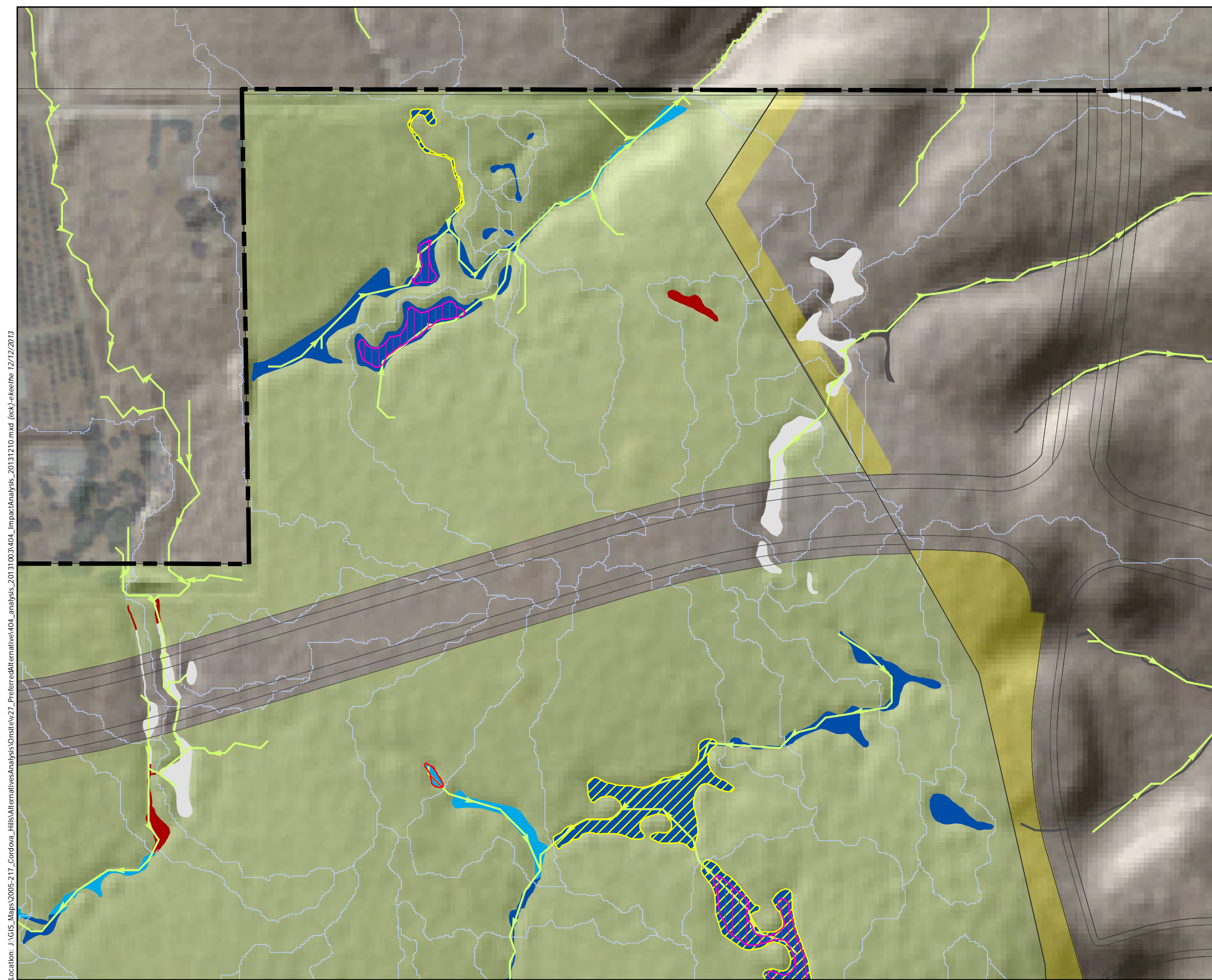
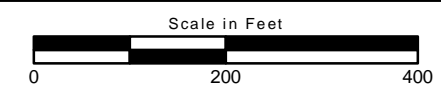
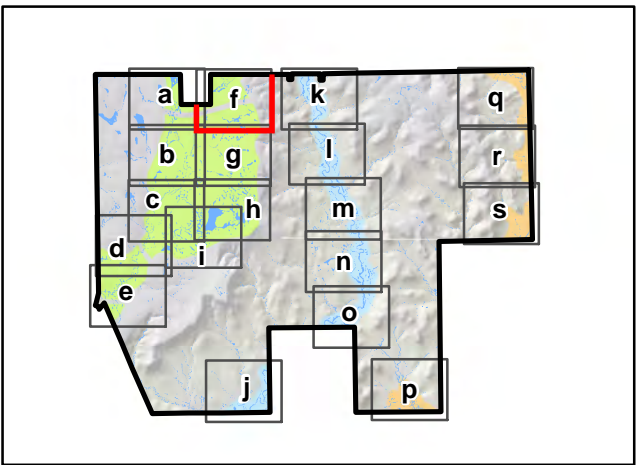


Figure 6f
On-Site Avoidance, Preservation
and Indirect Impact Detail

Map Features

- | | |
|--|----------------------------------|
| Project Boundary | DEM Derived Flowlines |
| Preserve Area | |
| Plateau | Edge Treatment (R2) ³ |
| Central Drainage | Feature Watersheds |
| Carson Creek | Survey Results |
| University | Branchinecta lynchi |
| 404 Wetland Impacts¹ | Lepidurus packardii |
| Avoided | Sacramento Orcutt Grass |
| Indirect Impact | |
| Direct Impact | |
| ESA Wetland Impacts² | |
| Avoided (Credit) | |
| Avoided (No Credit) | |
| Indirect Impact | |
| Direct Impact | |

- 1 - Non-Branchiopod Habitat Wetlands within 50 feet of Preserve edge are considered Indirectly Impacted
- 2 - All Non Directly Impacted Depressional Features within Central Drainage are Classified as Avoided.
- 3 - Edge Treatment consists of 50 ft. exterior addition to all preserve areas, except for the Central Drainage, which has a 100 ft. buffer except where this would encroach upon planned development areas.



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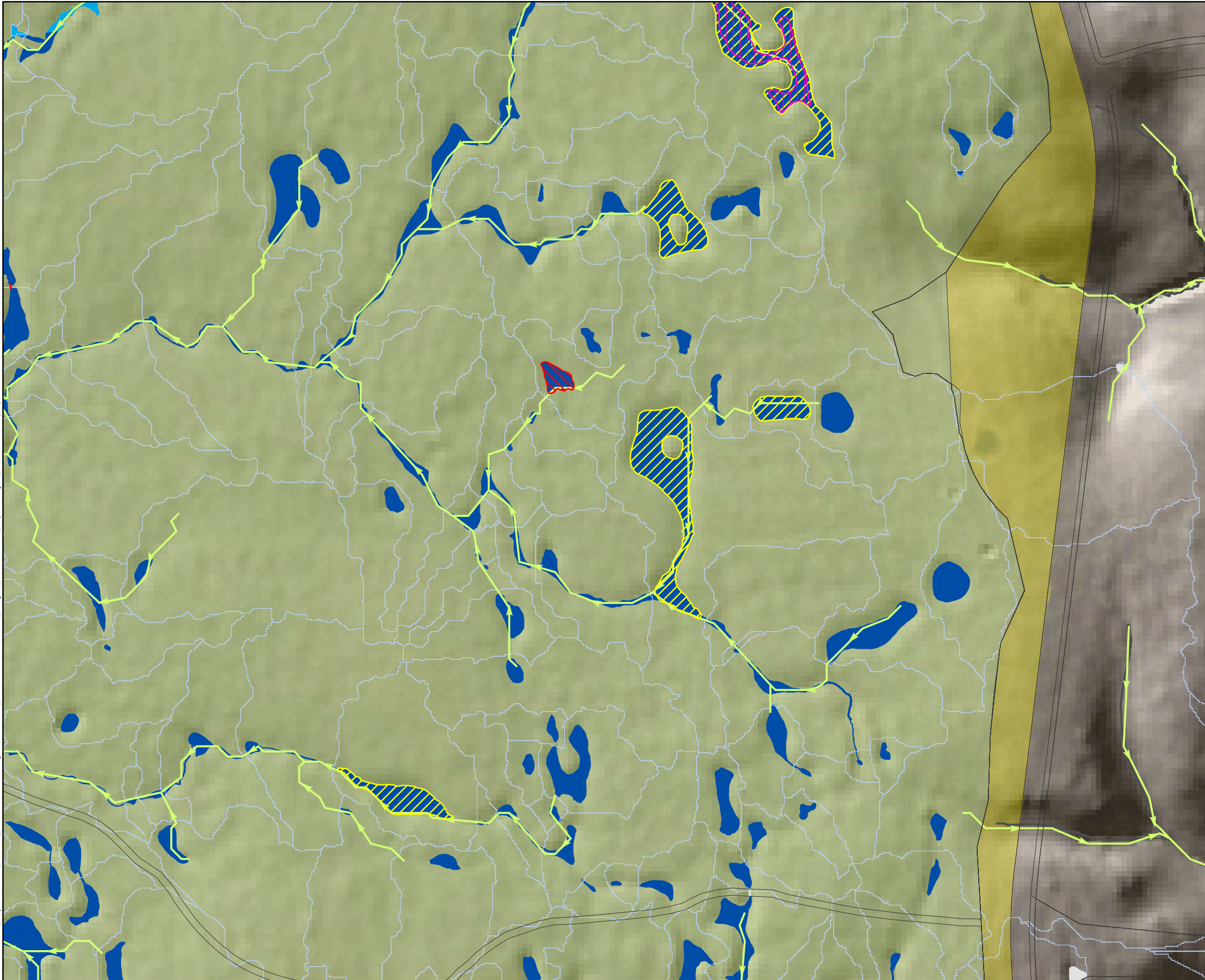
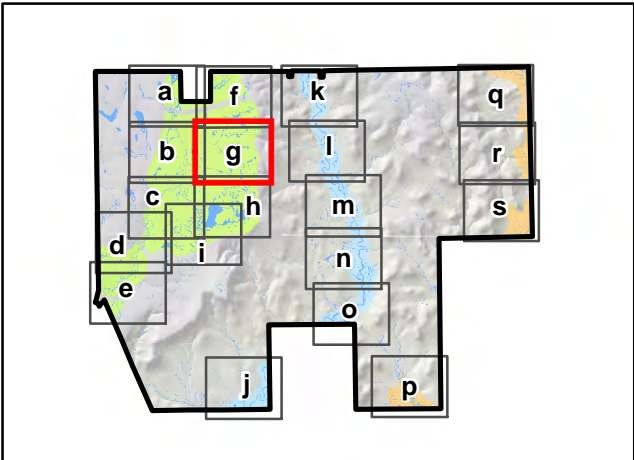


Figure 6g
On-Site Avoidance, Preservation
and Indirect Impact Detail

Map Features

- | | |
|--|----------------------------------|
| Project Boundary | DEM Derived Flowlines |
| Preserve Area | |
| Plateau | Edge Treatment (R2) ³ |
| Central Drainage | Feature Watersheds |
| Carson Creek | Survey Results |
| University | Branchinecta lynchi |
| 404 Wetland Impacts¹ | Lepidurus packardii |
| Avoided | Sacramento Orcutt Grass |
| Indirect Impact | |
| Direct Impact | |
| ESA Wetland Impacts² | |
| Avoided (Credit) | |
| Avoided (No Credit) | |
| Indirect Impact | |
| Direct Impact | |

1 - Non-Branchiopod Habitat Wetlands within 50 feet of Preserve edge are considered Indirectly Impacted
2 - All Non Directly Impacted Depressional Features within Central Drainage are Classified as Avoided.
3 - Edge Treatment consists of 50 ft. exterior addition to all preserve areas, except for the Central Drainage, which has a 100 ft. buffer except where this would encroach upon planned development areas.



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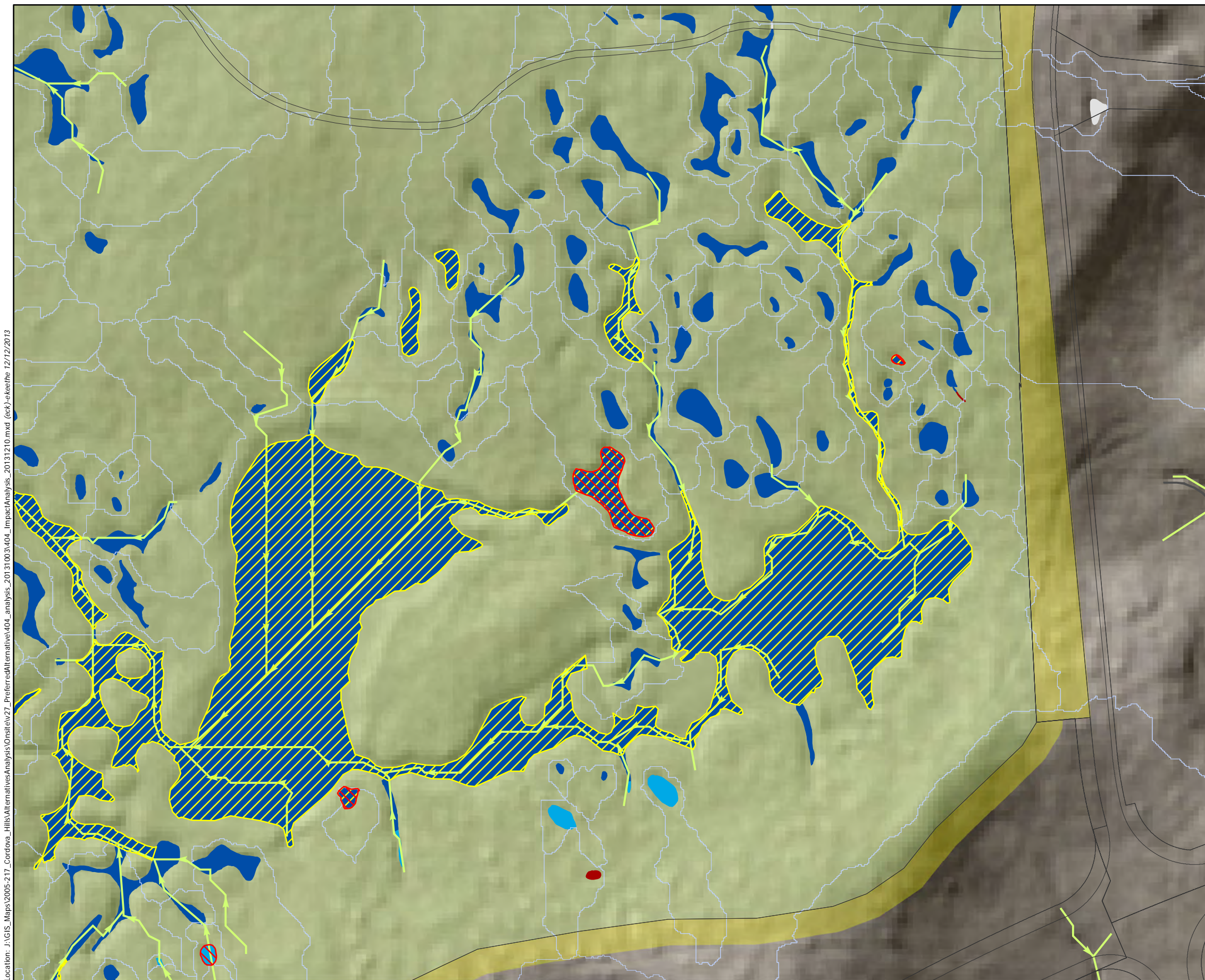
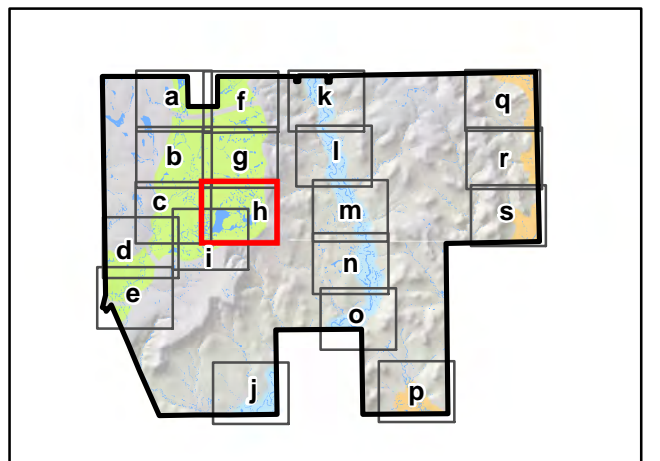


Figure 6h
On-Site Avoidance, Preservation
and Indirect Impact Detail

Map Features

- Project Boundary
- DEM Derived Flowlines
- Land Use
- Plateau
- Central Drainage
- Carson Creek
- University
- Edge Treatment (R2)³
- Feature Watersheds
- Survey Results**
Branchinecta lynchi
- Lepidurus packardii
- Sacramento Orcutt Grass
- 404 Wetland Impacts¹**
Avoided
- Indirect Impact
- Direct Impact
- ESA Wetland Impacts²**
Avoided (Credit)
- Avoided (No Credit)
- Indirect Impact
- Direct Impact

- 1 - Non-Branchiopod Habitat Wetlands within 50 feet of Preserve edge are considered Indirectly Impacted
- 2 - All Non Directly Impacted Depressional Features within Central Drainage are Classified as Avoided.
- 3 - Edge Treatment consists of 50 ft. exterior addition to all preserve areas, except for the Central Drainage, which has a 100 ft. buffer except where this would encroach upon planned development areas.



Location: J:\GIS_Maps\2005-217_Cordova_Hills\AlternativesAnalysis\OnSite\elv27_Prefereed\Alternative404_analysis_20131003\404_ImpactAnalysis_20131210.mxd (eck) ekeefhe 12/12/2013

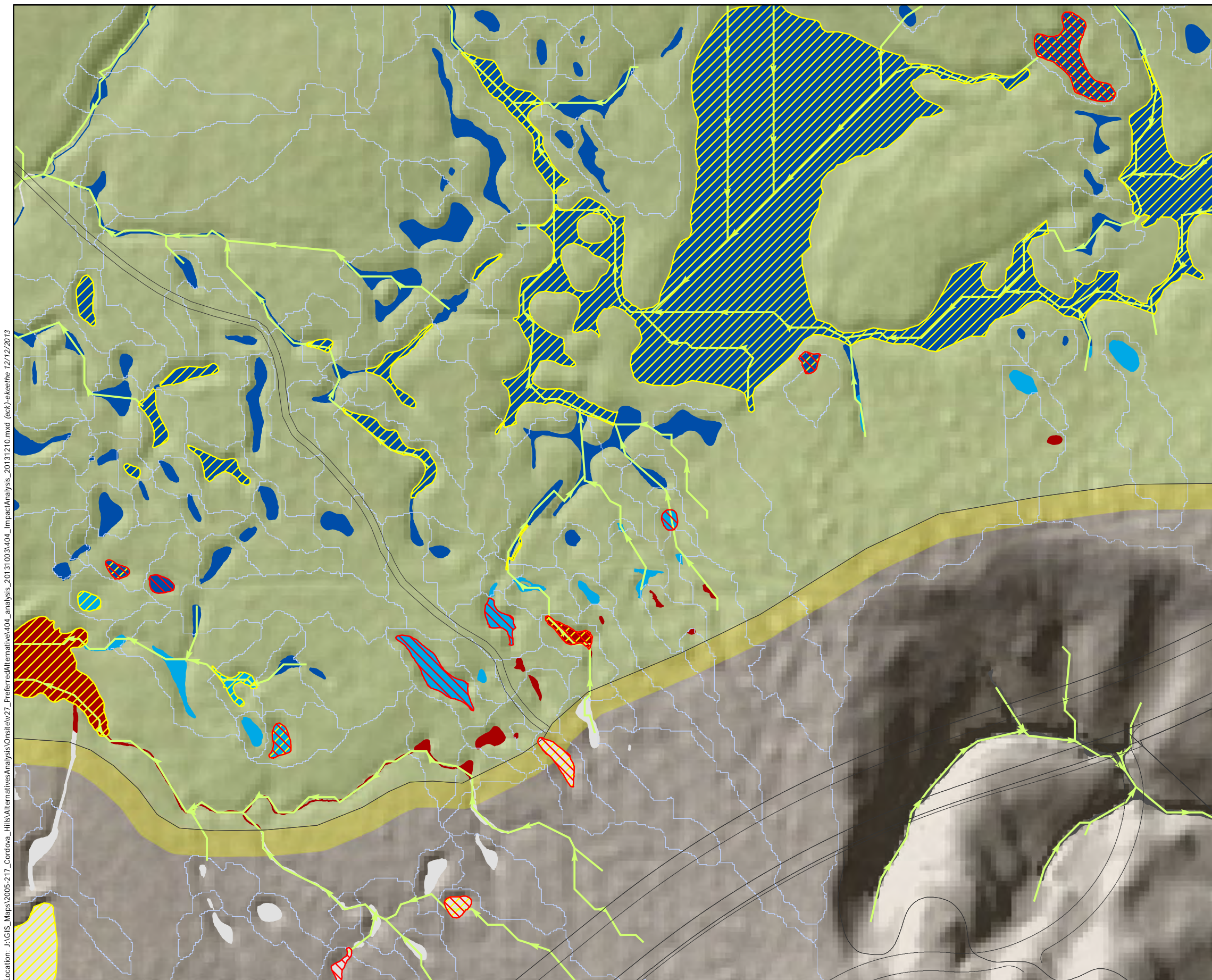

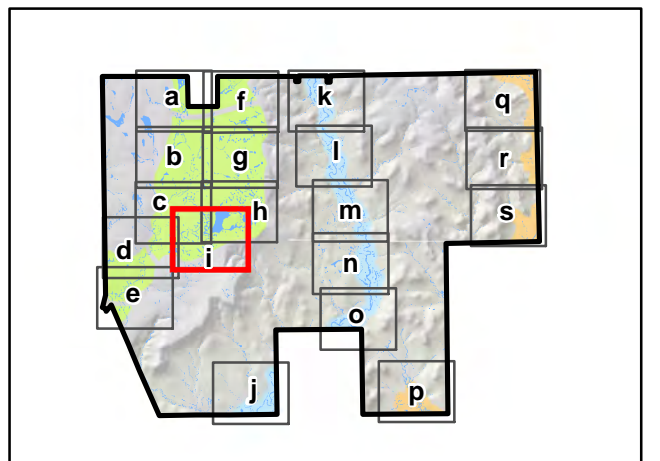


Figure 6i
On-Site Avoidance, Preservation
and Indirect Impact Detail

Map Features

-  Project Boundary
-  DEM Derived Flowlines
- Preserve Area**
-  Plateau
-  Central Drainage
-  Carson Creek
-  University
-  Edge Treatment (R2)³
-  Feature Watersheds
- Survey Results**
-  Branchinecta lynchi
-  Lepidurus packardii
-  Sacramento Orcutt Grass
- 404 Wetland Impacts¹**
-  Avoided
-  Indirect Impact
-  Direct Impact
- ESA Wetland Impacts²**
-  Avoided (Credit)
-  Avoided (No Credit)
-  Indirect Impact
-  Direct Impact

- 1 - Non-Branchiopod Habitat Wetlands within 50 feet of Preserve edge are considered Indirectly Impacted
- 2 - All Non Directly Impacted Depressional Features within Central Drainage are Classified as Avoided.
- 3 - Edge Treatment consists of 50 ft. exterior addition to all preserve areas, except for the Central Drainage, which has a 100 ft. buffer except where this would encroach upon planned development areas.



Location: J:\GIS_Maps\2005-217_Cordova_Hills\AlternativesAnalysis\OnSite\27_Prefered\Analysis\404_analysis_20131210.mxd (eck) ekeefhe 12/12/2013

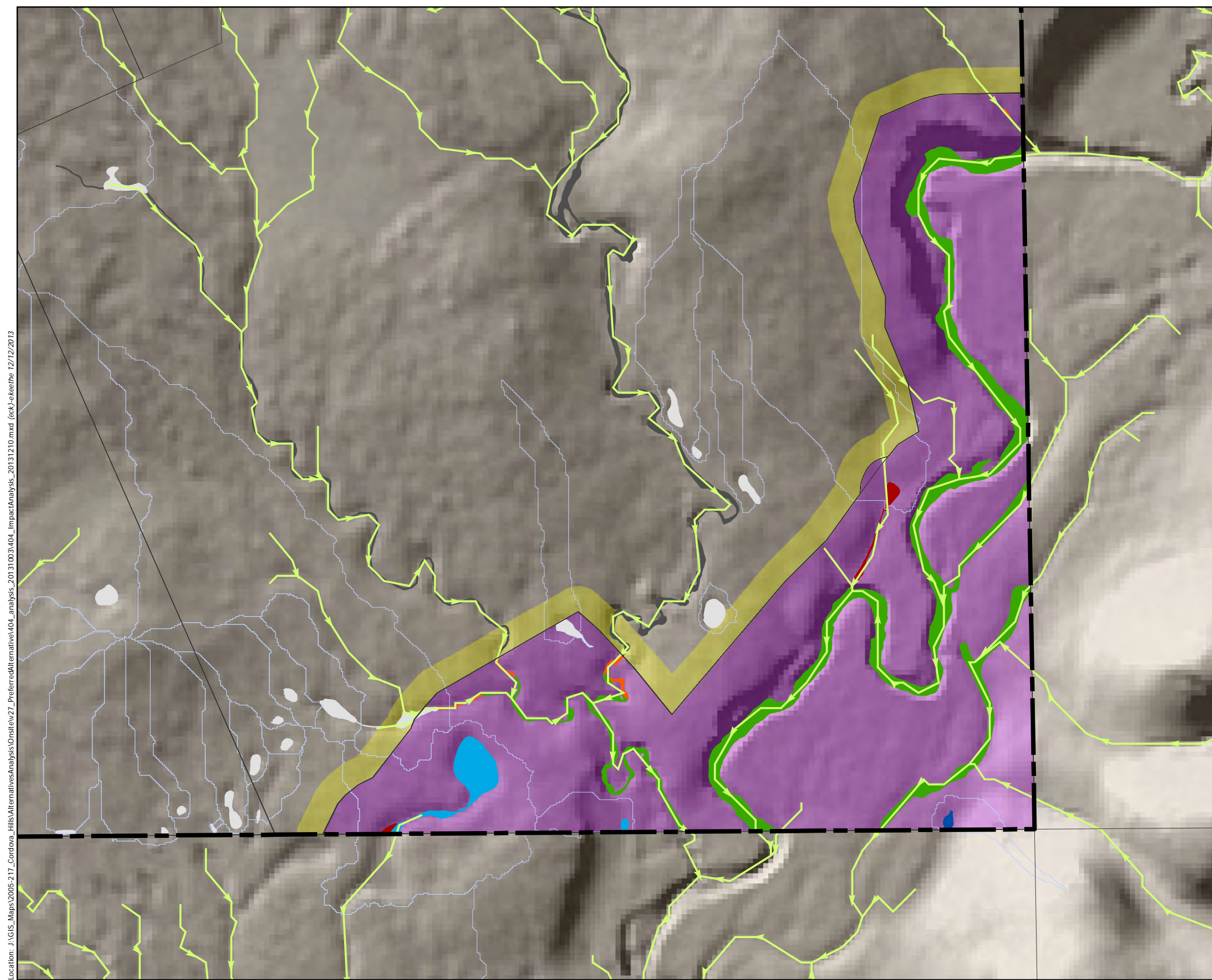
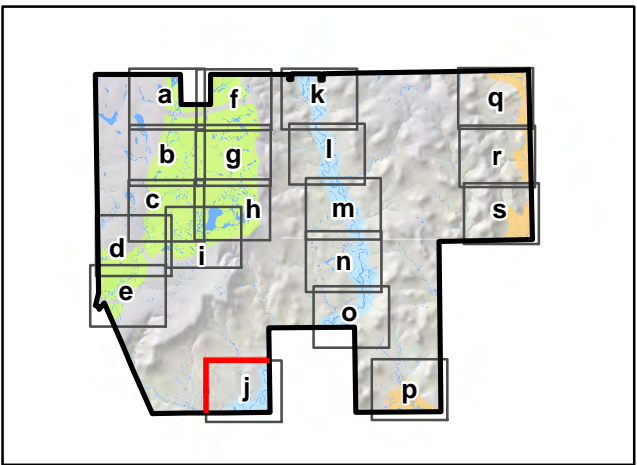


Figure 6j
On-Site Avoidance, Preservation
and Indirect Impact Detail

Map Features

- | | |
|--|----------------------------------|
| Project Boundary | DEM Derived Flowlines |
| Preserve Area | |
| Plateau | Land Use |
| Central Drainage | Edge Treatment (R2) ³ |
| Carson Creek | Feature Watersheds |
| University | Survey Results |
| 404 Wetland Impacts ¹ | Branchinecta lynchi |
| Avoided | Lepidurus packardii |
| Indirect Impact | Sacramento Orcutt Grass |
| Direct Impact | |
| ESA Wetland Impacts² | |
| Avoided (Credit) | |
| Avoided (No Credit) | |
| Indirect Impact | |
| Direct Impact | |



















- 1 - Non-Branchiopod Habitat Wetlands within 50 feet of Preserve edge are considered Indirectly Impacted
- 2 - All Non Directly Impacted Depressional Features within Central Drainage are Classified as Avoided.
- 3 - Edge Treatment consists of 50 ft. exterior addition to all preserve areas, except for the Central Drainage, which has a 100 ft. buffer except where this would encroach upon planned development areas.



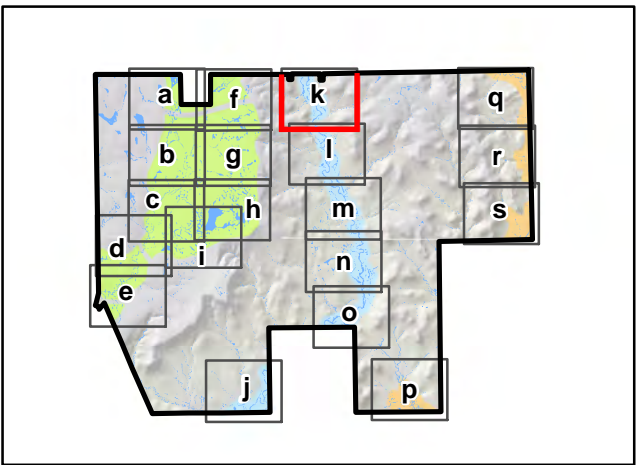
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Figure 6k
On-Site Avoidance, Preservation
and Indirect Impact Detail

Map Features

- | | |
|--|--|
|  Project Boundary |  DEM Derived Flowlines |
| Preserve Area | |
|  Plateau |  Land Use |
|  Central Drainage |  Edge Treatment (R2) ³ |
|  Carson Creek |  Feature Watersheds |
|  University | Survey Results |
|  404 Wetland Impacts ¹ |  Branchinecta lynchi |
|  Avoided |  Lepidurus packardii |
|  Indirect Impact |  Sacramento Orcutt Grass |
|  Direct Impact | |
| ESA Wetland Impacts² | |
|  Avoided (Credit) | |
|  Avoided (No Credit) | |
|  Indirect Impact | |
|  Direct Impact | |

- 1 - Non-Branchiopod Habitat Wetlands within 50 feet of Preserve edge are considered Indirectly Impacted
- 2 - All Non Directly Impacted Depressional Features within Central Drainage are Classified as Avoided.
- 3 - Edge Treatment consists of 50 ft. exterior addition to all preserve areas, except for the Central Drainage, which has a 100 ft. buffer except where this would encroach upon planned development areas.



Location: J:\GIS_Maps\2005-217_Cordova_Hills\AlternativesAnalysis\OnSite\elv27_Prefered\Alternative404_analysis_20131003\404_ImpactAnalysis_20131210.mxd (eck) ekeefhe 12/12/2013

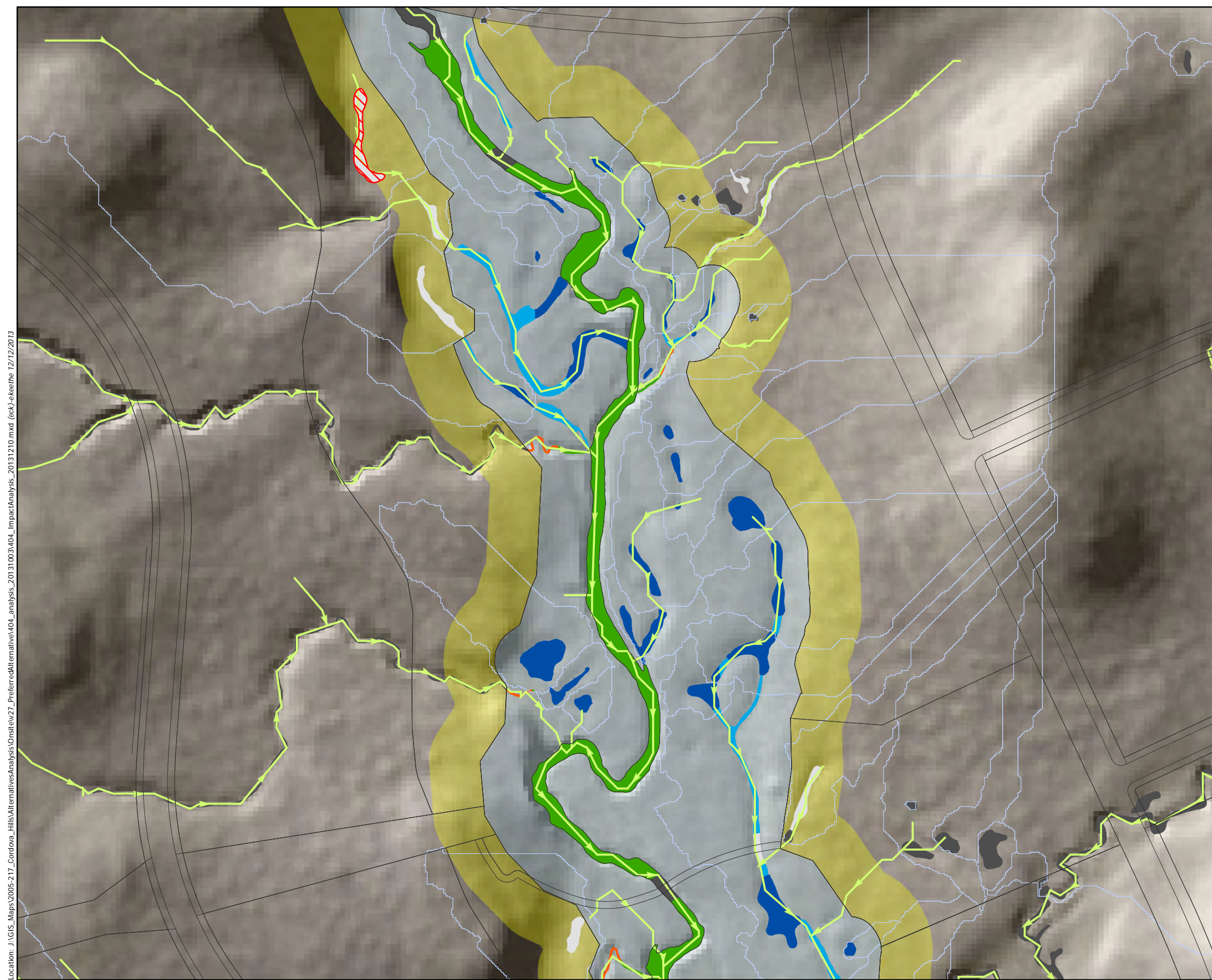
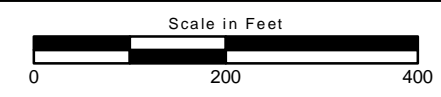
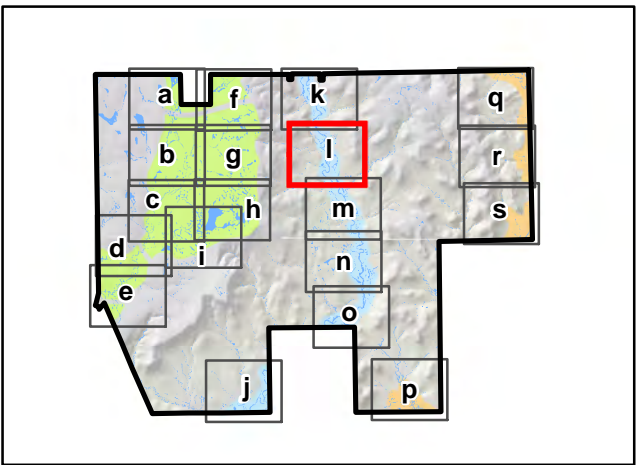


Figure 6I
On-Site Avoidance, Preservation
and Indirect Impact Detail

Map Features

- | | |
|-----------------------------|-------------------------|
| Project Boundary | DEM Derived Flowlines |
| Preserve Area | |
| Plateau | Edge Treatment (R2)³ |
| Central Drainage | Feature Watersheds |
| Carson Creek | Survey Results |
| University | Branchinecta lynchi |
| 404 Wetland Impacts¹ | Lepidurus packardii |
| Avoided | Sacramento Orcutt Grass |
| Indirect Impact | |
| Direct Impact | |
| ESA Wetland Impacts² | |
| Avoided (Credit) | |
| Avoided (No Credit) | |
| Indirect Impact | |
| Direct Impact | |
















- 1 - Non-Branchiopod Habitat Wetlands within 50 feet of Preserve edge are considered Indirectly Impacted
- 2 - All Non Directly Impacted Depressional Features within Central Drainage are Classified as Avoided.
- 3 - Edge Treatment consists of 50 ft. exterior addition to all preserve areas, except for the Central Drainage, which has a 100 ft. buffer except where this would encroach upon planned development areas.



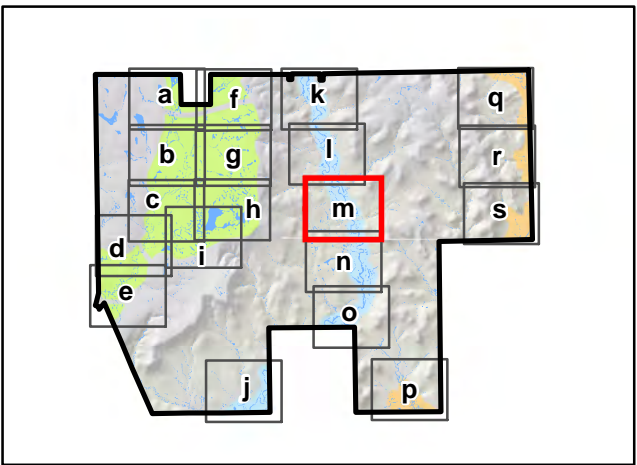
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Figure 6m
On-Site Avoidance, Preservation
and Indirect Impact Detail

Map Features

- | | |
|---|---|
|  Project Boundary |  DEM Derived Flowlines |
| Preserve Area | |
|  Plateau |  Edge Treatment (R2)³ |
|  Central Drainage |  Feature Watersheds |
|  Carson Creek | Survey Results |
|  University |  Branchinecta lynchi |
| 404 Wetland Impacts¹ |  Lepidurus packardii |
|  Avoided |  Sacramento Orcutt Grass |
|  Indirect Impact | |
|  Direct Impact | |
| ESA Wetland Impacts² | |
|  Avoided (Credit) | |
|  Avoided (No Credit) | |
|  Indirect Impact | |
|  Direct Impact | |

- 1 - Non-Branchiopod Habitat Wetlands within 50 feet of Preserve edge are considered Indirectly Impacted
- 2 - All Non Directly Impacted Depressional Features within Central Drainage are Classified as Avoided.
- 3 - Edge Treatment consists of 50 ft. exterior addition to all preserve areas, except for the Central Drainage, which has a 100 ft. buffer except where this would encroach upon planned development areas.



Location: J:\GIS_Maps\2005-217_Cordova_Hills\AlternativesAnalysis\OnSite\ev27_Prefered\Alternative404_analysis_20131003\404_ImpactAnalysis_20131210.mxd (eck) ekeefhe 12/12/2013

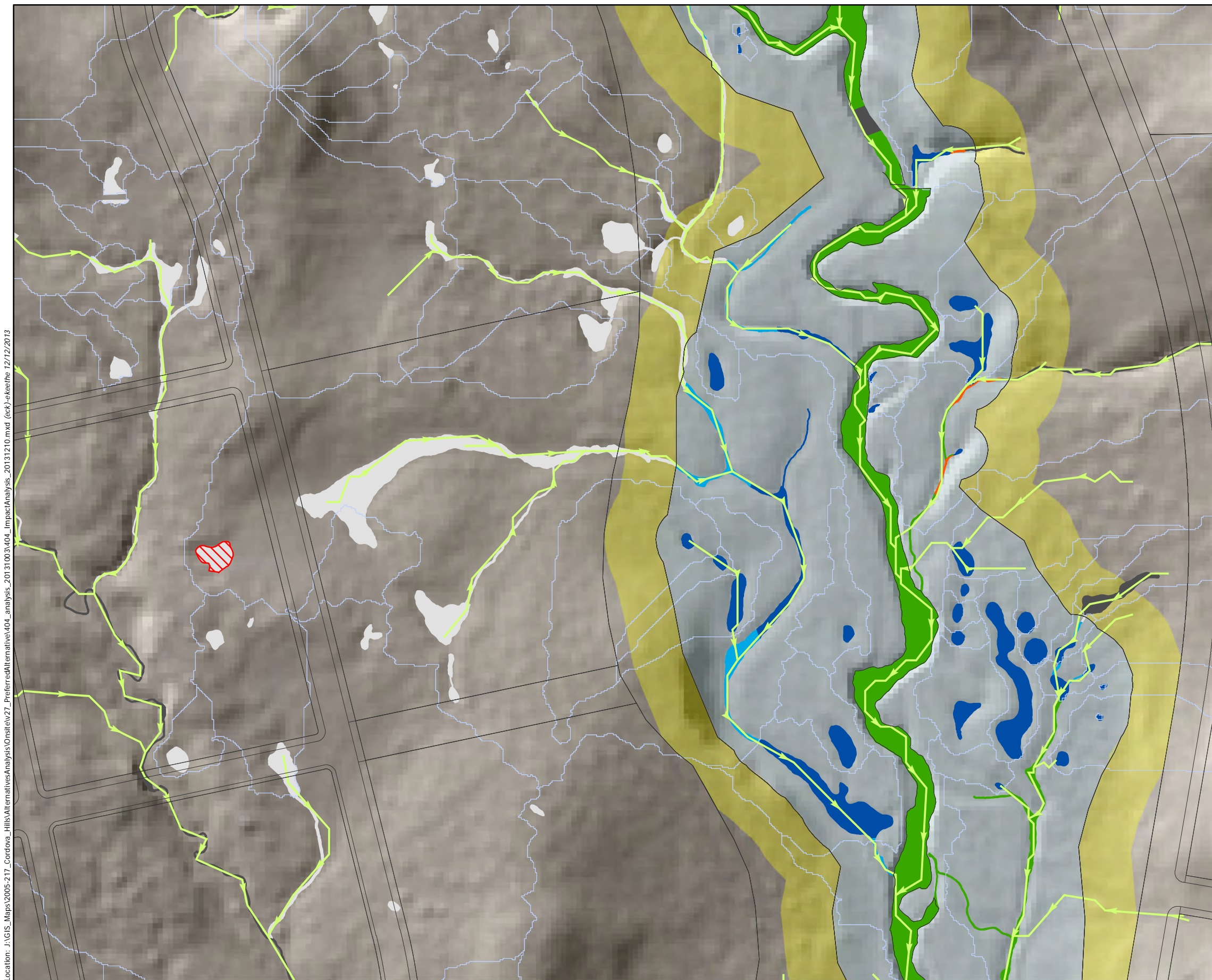
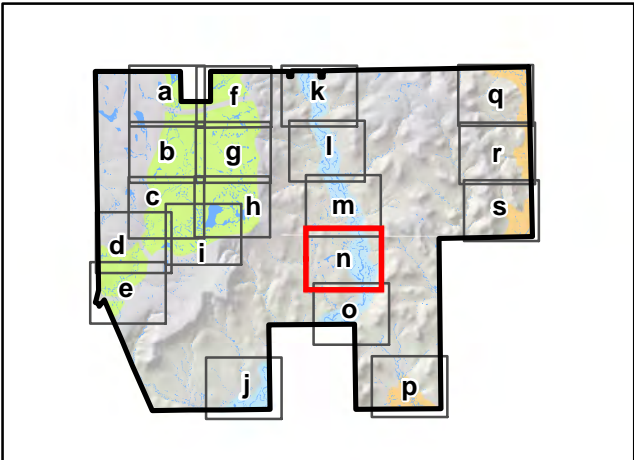


Figure 6n
On-Site Avoidance, Preservation
and Indirect Impact Detail

Map Features

- Project Boundary
- DEM Derived Flowlines
- Preserve Area**
 - Plateau
 - Central Drainage
 - Carson Creek
 - University
- Edge Treatment (R2)³
- Feature Watersheds
- Survey Results**
 - Branchinecta lynchi
 - Lepidurus packardii
 - Sacramento Orcutt Grass
- 404 Wetland Impacts¹**
 - Avoided
 - Indirect Impact
 - Direct Impact
- ESA Wetland Impacts²**
 - Avoided (Credit)
 - Avoided (No Credit)
 - Indirect Impact
 - Direct Impact

1 - Non-Branchiopod Habitat Wetlands within 50 feet of Preserve edge are considered Indirectly Impacted
2 - All Non Directly Impacted Depressional Features within Central Drainage are Classified as Avoided.
3 - Edge Treatment consists of 50 ft. exterior addition to all preserve areas, except for the Central Drainage, which has a 100 ft. buffer except where this would encroach upon planned development areas.



Location: J:\GIS_Maps\2005-217_Cordova_Hills\AlternativesAnalysis\OnSite\27_PreferedAlternative\404_analysis_20131003\404_ImpactAnalysis_20131210.mxd (eck) ekeefhe 12/12/2013

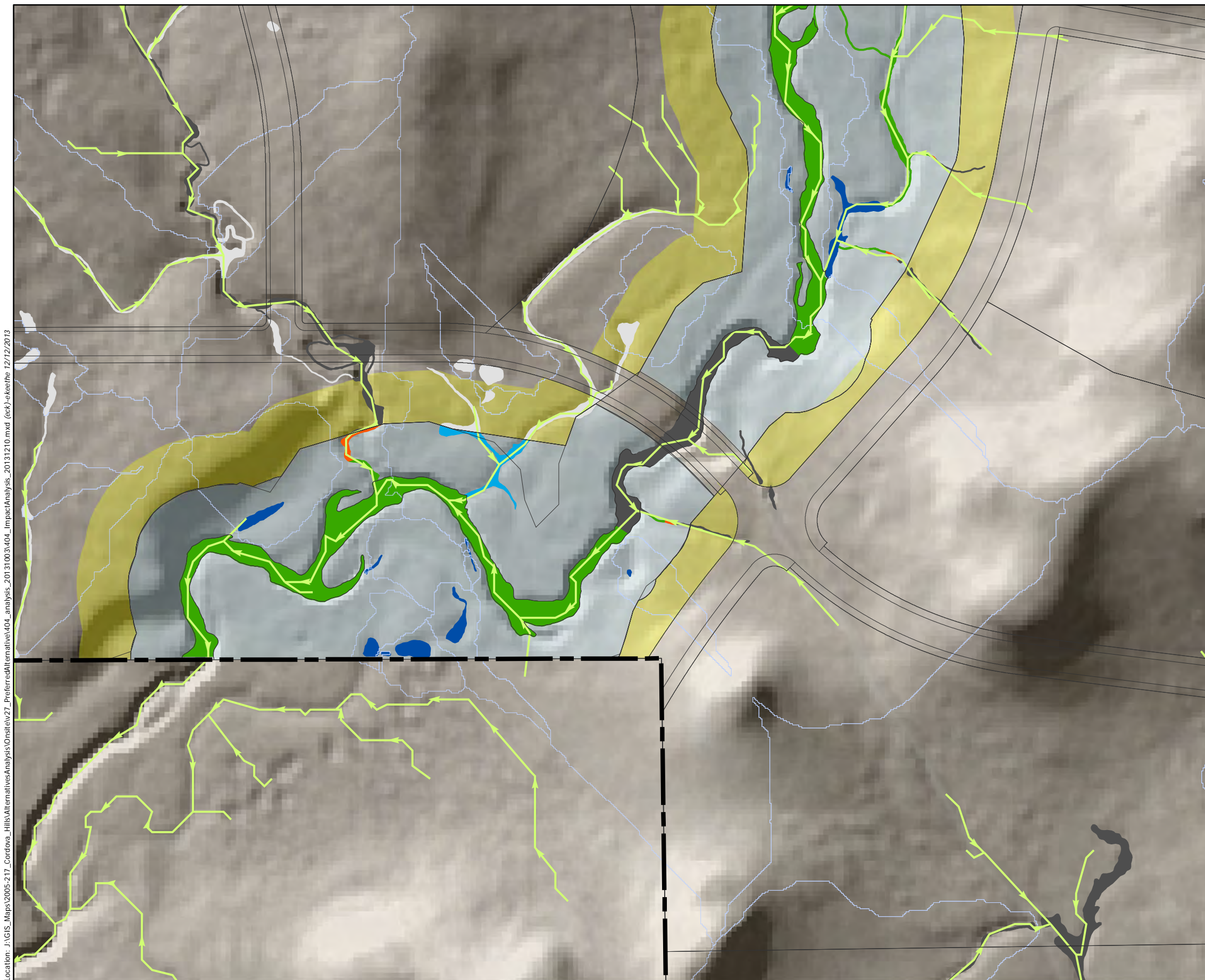
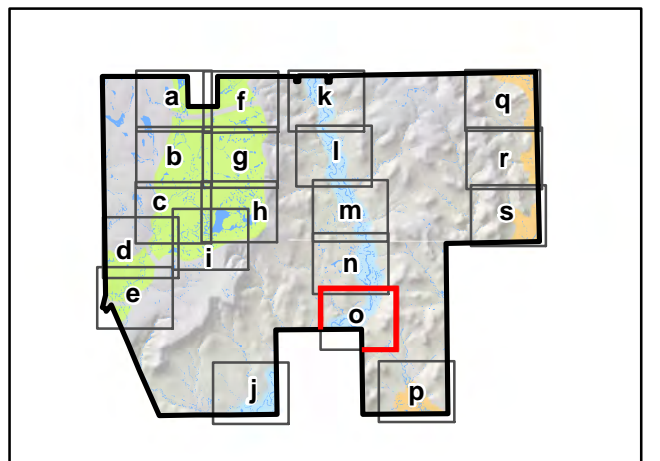


Figure 60
On-Site Avoidance, Preservation
and Indirect Impact Detail

Map Features

- Project Boundary
- DEM Derived Flowlines
- Preserve Area**
 - Plateau
 - Central Drainage
 - Carson Creek
 - University
- Edge Treatment (R2)³
- Feature Watersheds
- Survey Results**
 - Branchinecta lynchi
 - Lepidurus packardii
 - Sacramento Orcutt Grass
- 404 Wetland Impacts¹**
 - Avoided
 - Indirect Impact
 - Direct Impact
- ESA Wetland Impacts²**
 - Avoided (Credit)
 - Avoided (No Credit)
 - Indirect Impact
 - Direct Impact

- 1 - Non-Branchiopod Habitat Wetlands within 50 feet of Preserve edge are considered Indirectly Impacted
- 2 - All Non Directly Impacted Depressional Features within Central Drainage are Classified as Avoided.
- 3 - Edge Treatment consists of 50 ft. exterior addition to all preserve areas, except for the Central Drainage, which has a 100 ft. buffer except where this would encroach upon planned development areas.



Location: J:\GIS_Maps\2005-217_Cordova_Hills\AlternativesAnalysis\OnSite\27_PreferedAlternative\404_analysis_20131003\404_ImpactAnalysis_20131210.mxd (eck) ekeefhe 12/12/2013

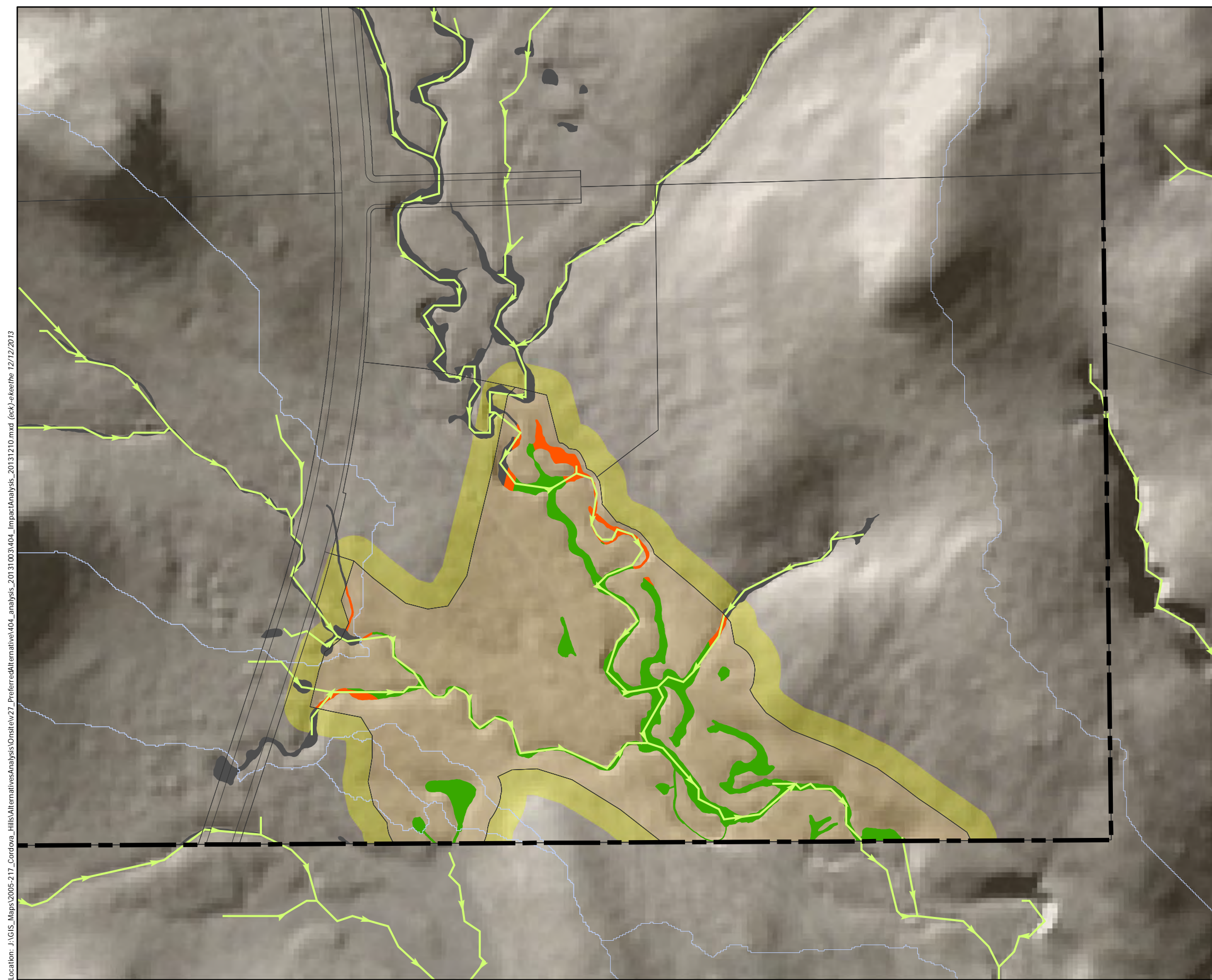
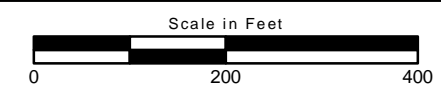
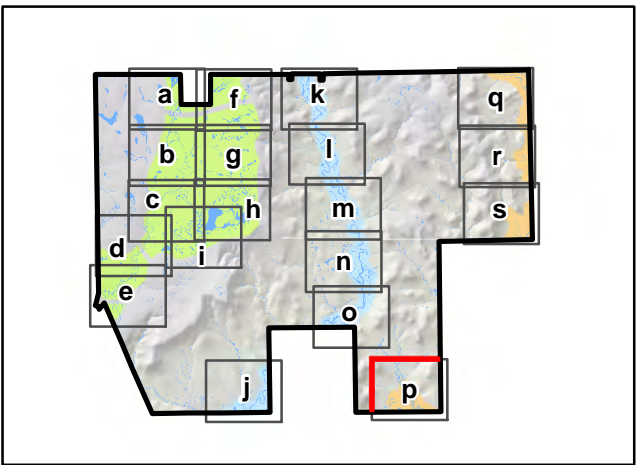


Figure 6p
On-Site Avoidance, Preservation
and Indirect Impact Detail

Map Features

- | | |
|--|----------------------------------|
| Project Boundary | DEM Derived Flowlines |
| Preserve Area | |
| Plateau | Edge Treatment (R2) ³ |
| Central Drainage | Feature Watersheds |
| Carson Creek | Survey Results |
| University | Branchinecta lynchi |
| 404 Wetland Impacts¹ | Lepidurus packardii |
| Avoided | Sacramento Orcutt Grass |
| Indirect Impact | |
| Direct Impact | |
| ESA Wetland Impacts² | |
| Avoided (Credit) | |
| Avoided (No Credit) | |
| Indirect Impact | |
| Direct Impact | |

- 1 - Non-Branchiopod Habitat Wetlands within 50 feet of Preserve edge are considered Indirectly Impacted
- 2 - All Non Directly Impacted Depressional Features within Central Drainage are Classified as Avoided.
- 3 - Edge Treatment consists of 50 ft. exterior addition to all preserve areas, except for the Central Drainage, which has a 100 ft. buffer except where this would encroach upon planned development areas.



Location: J:\GIS_Maps\2005-217_Cordova_Hills\AlternativesAnalysis\OnSite\elv27_Prefered\Alternative404_analysis_20131003\404_ImpactAnalysis_20131210.mxd (eck) eke@the 12/12/2013

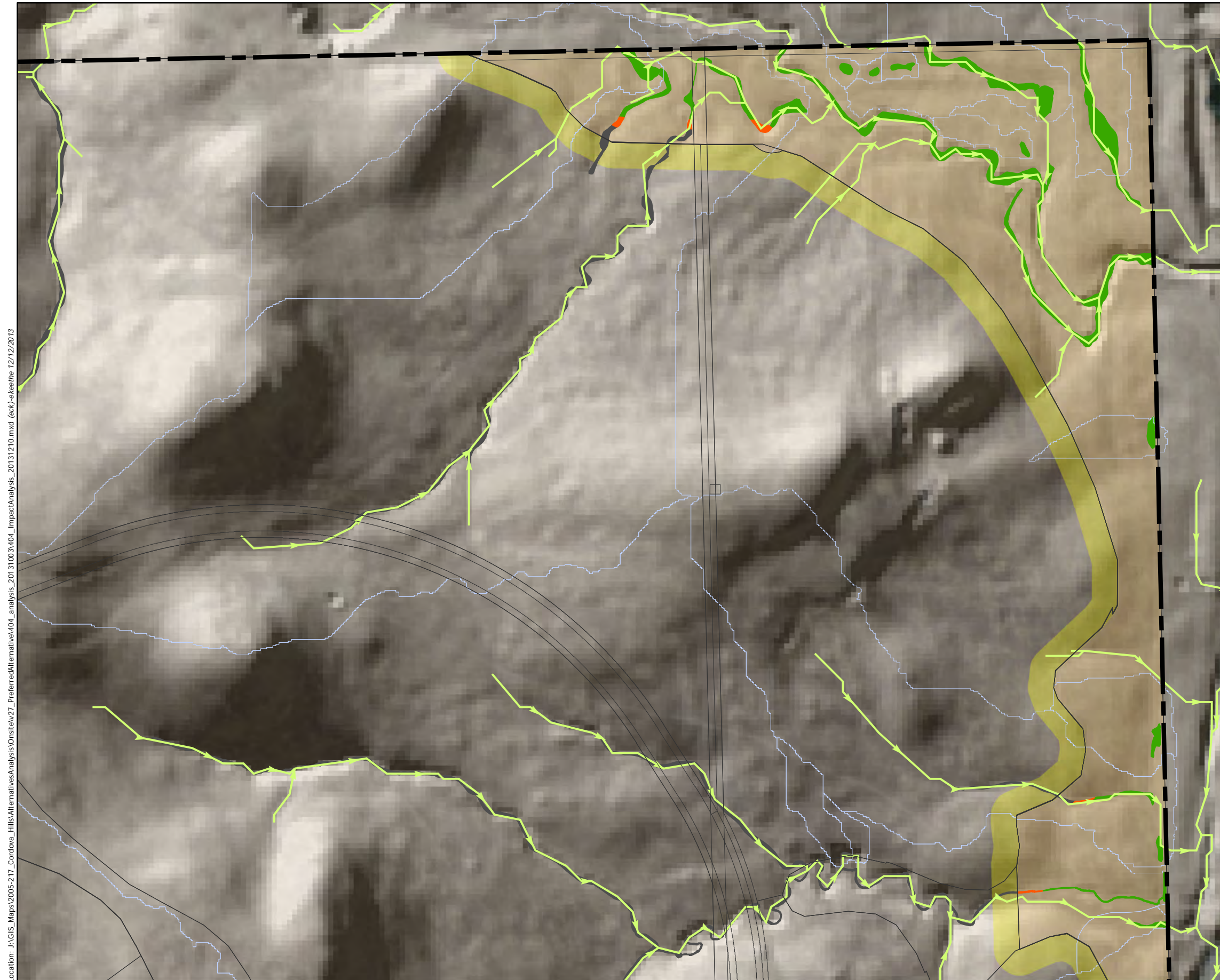
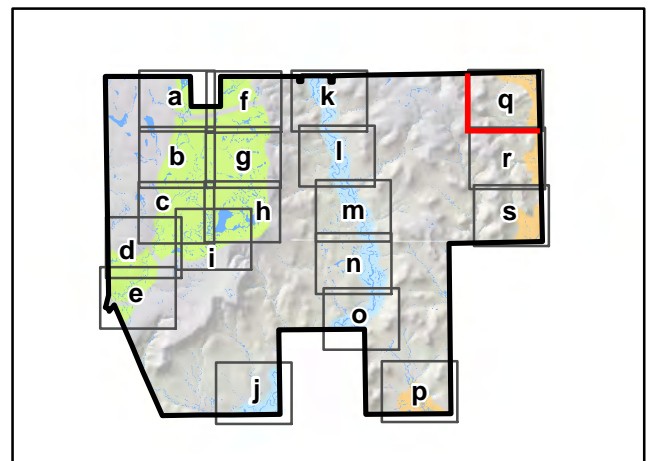


Figure 6q
On-Site Avoidance, Preservation
and Indirect Impact Detail

Map Features

- | | |
|-----------------------------|-------------------------|
| Project Boundary | DEM Derived Flowlines |
| Preserve Area | |
| Plateau | Edge Treatment (R2)³ |
| Central Drainage | Feature Watersheds |
| Carson Creek | Survey Results |
| University | Branchinecta lynchi |
| 404 Wetland Impacts¹ | Lepidurus packardii |
| Avoided | Sacramento Orcutt Grass |
| Indirect Impact | |
| Direct Impact | |
| ESA Wetland Impacts² | |
| Avoided (Credit) | |
| Avoided (No Credit) | |
| Indirect Impact | |
| Direct Impact | |


















- 1 - Non-Branchiopod Habitat Wetlands within 50 feet of Preserve edge are considered Indirectly Impacted
- 2 - All Non Directly Impacted Depressional Features within Central Drainage are Classified as Avoided.
- 3 - Edge Treatment consists of 50 ft. exterior addition to all preserve areas, except for the Central Drainage, which has a 100 ft. buffer except where this would encroach upon planned development areas.



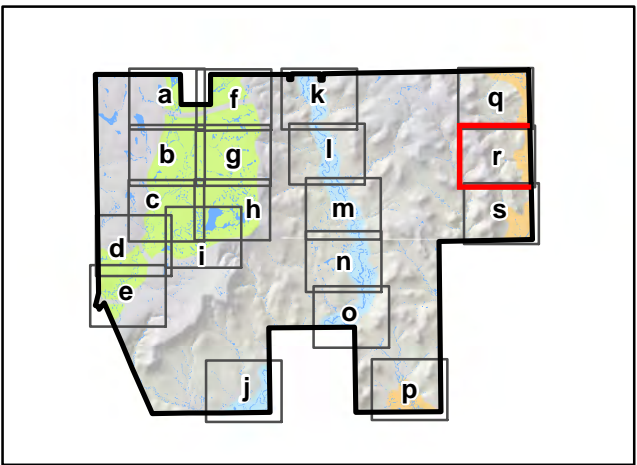
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Figure 6r
On-Site Avoidance, Preservation
and Indirect Impact Detail

Map Features

- | | |
|--|--|
|  Project Boundary |  DEM Derived Flowlines |
| Preserve Area | |
|  Plateau |  Land Use |
|  Central Drainage |  Edge Treatment (R2) ³ |
|  Carson Creek |  Feature Watersheds |
|  University | Survey Results |
|  404 Wetland Impacts ¹ Avoided |  Branchinecta lynchi |
|  404 Wetland Impacts ¹ Indirect Impact |  Lepidurus packardii |
|  404 Wetland Impacts ¹ Direct Impact |  Sacramento Orcutt Grass |
| ESA Wetland Impacts² | |
|  ESA Wetland Impacts ² Avoided (Credit) | |
|  ESA Wetland Impacts ² Avoided (No Credit) | |
|  ESA Wetland Impacts ² Indirect Impact | |
|  ESA Wetland Impacts ² Direct Impact | |

- 1 - Non-Branchiopod Habitat Wetlands within 50 feet of Preserve edge are considered Indirectly Impacted
- 2 - All Non Directly Impacted Depressional Features within Central Drainage are Classified as Avoided.
- 3 - Edge Treatment consists of 50 ft. exterior addition to all preserve areas, except for the Central Drainage, which has a 100 ft. buffer except where this would encroach upon planned development areas.



Location: J:\GIS Maps\2005-217_Cordova_Hills\AlternativesAnalysis\OnSite\27_Prefered\Alternative 404_analysis_20131003\404_ImpactAnalysis_20131210.mxd (eck) ekeefhe 12/12/2013

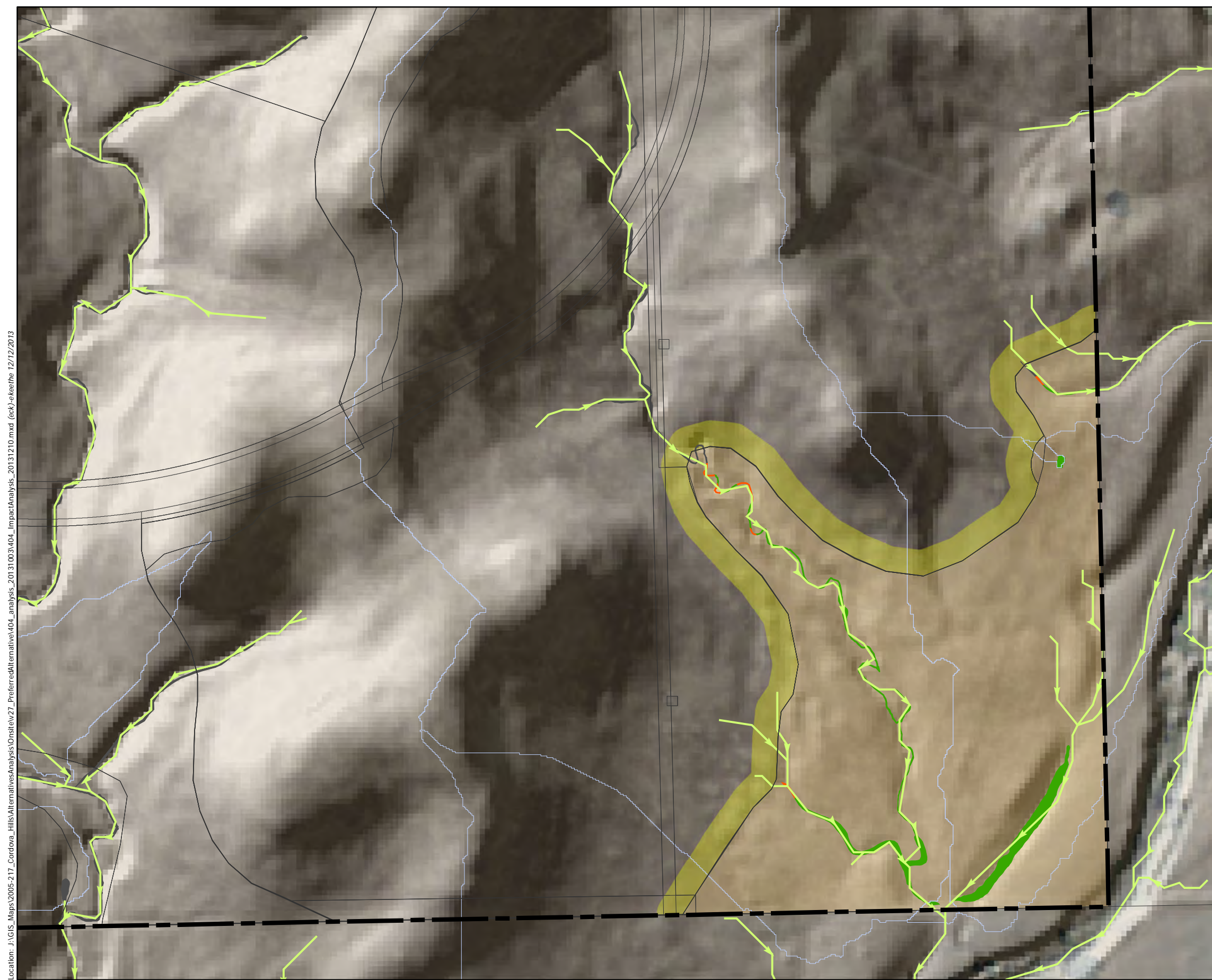
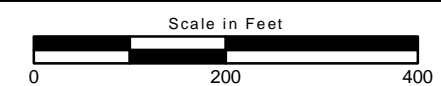
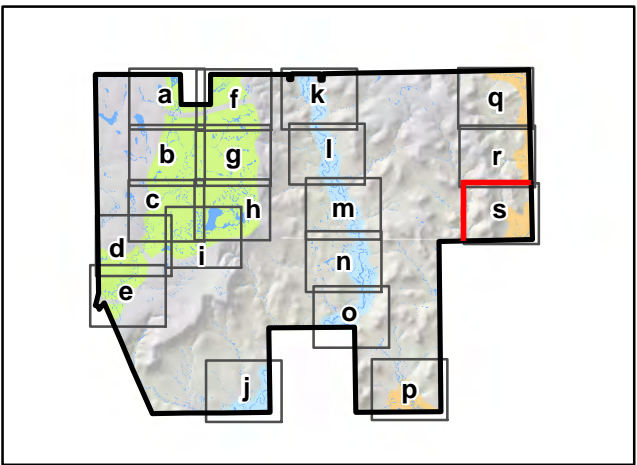


Figure 6s
On-Site Avoidance, Preservation
and Indirect Impact Detail

Map Features

- | | |
|-----------------------------|-------------------------|
| Project Boundary | DEM Derived Flowlines |
| Preserve Area | |
| Plateau | Edge Treatment (R2)³ |
| Central Drainage | Feature Watersheds |
| Carson Creek | Survey Results |
| University | Branchinecta lynchi |
| 404 Wetland Impacts¹ | Lepidurus packardii |
| Avoided | Sacramento Orcutt Grass |
| Indirect Impact | |
| Direct Impact | |
| ESA Wetland Impacts² | |
| Avoided (Credit) | |
| Avoided (No Credit) | |
| Indirect Impact | |
| Direct Impact | |

- 1 - Non-Branchiopod Habitat Wetlands within 50 feet of Preserve edge are considered Indirectly Impacted
- 2 - All Non Directly Impacted Depressional Features within Central Drainage are Classified as Avoided.
- 3 - Edge Treatment consists of 50 ft. exterior addition to all preserve areas, except for the Central Drainage, which has a 100 ft. buffer except where this would encroach upon planned development areas.



LIST OF ATTACHMENTS

Attachment A – Cordova Hills Edge Treatments

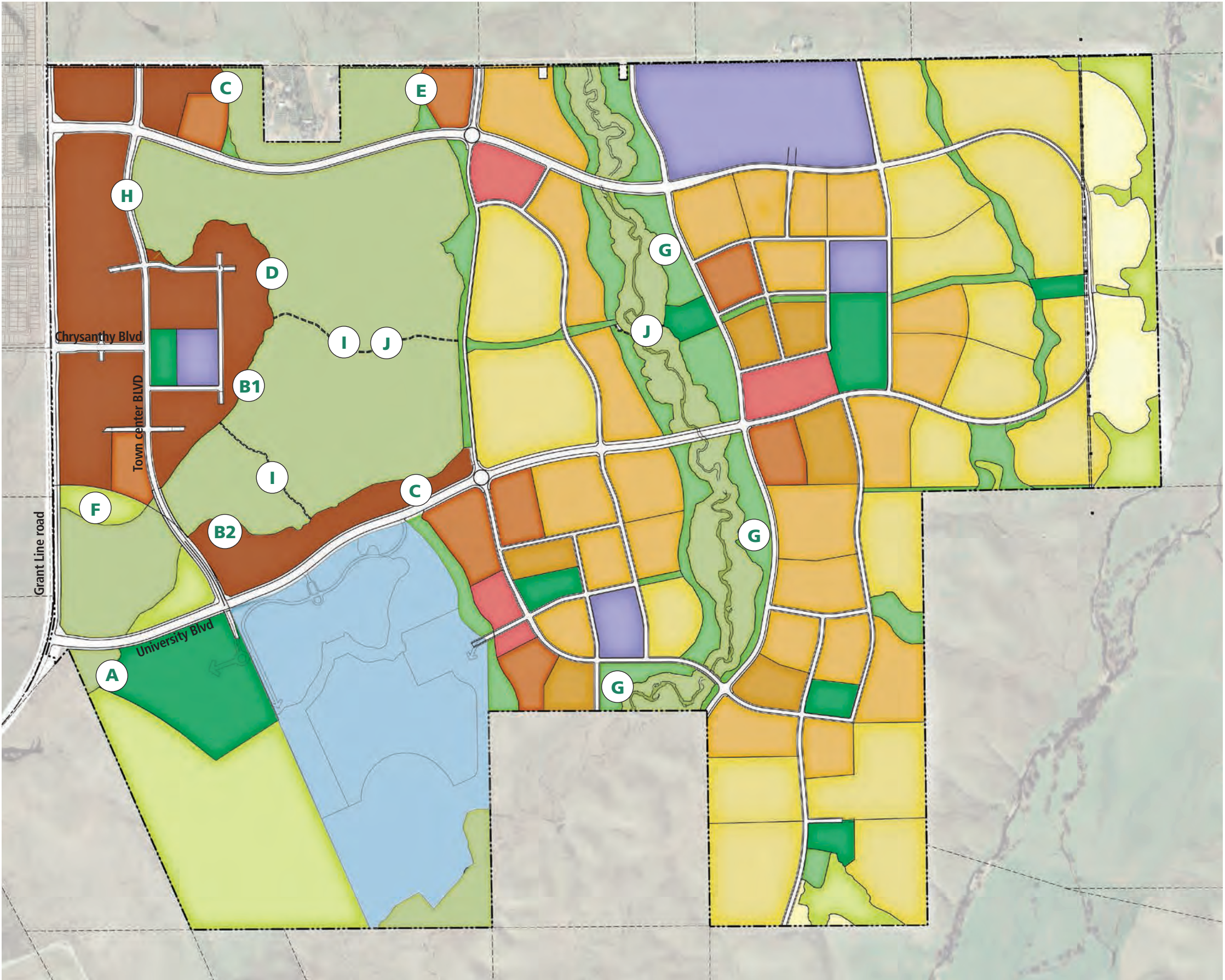
Attachment B – Refinements to the Mather Core Area at Cordova Hills

ATTACHMENT A

Cordova Hills Edge Treatments



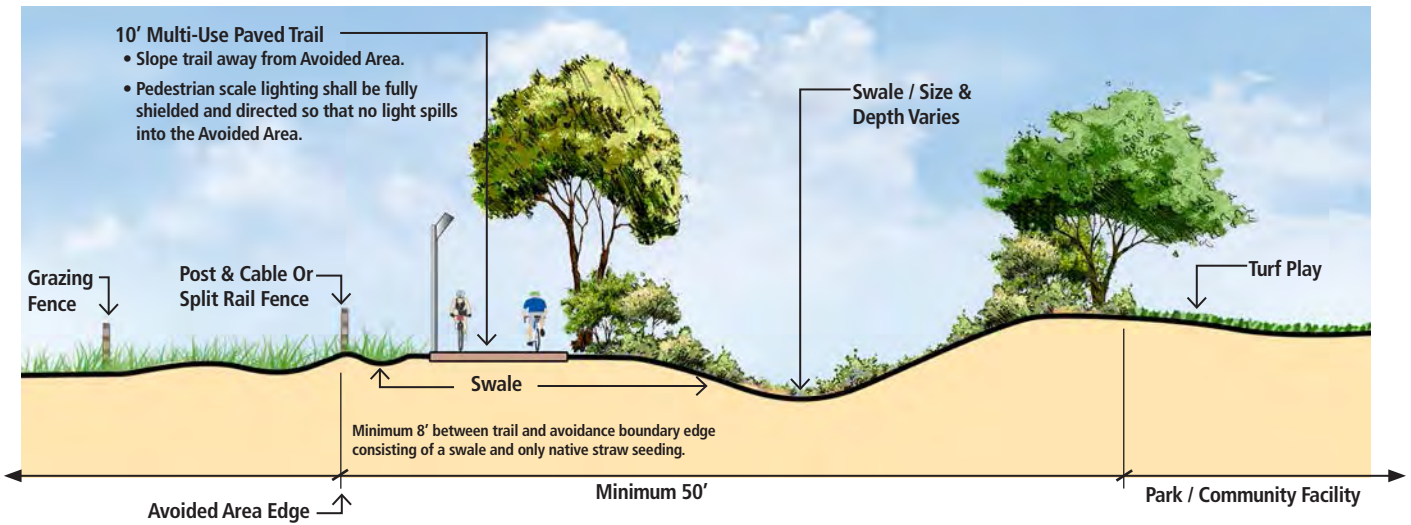
404 Permit
July 21, 2014



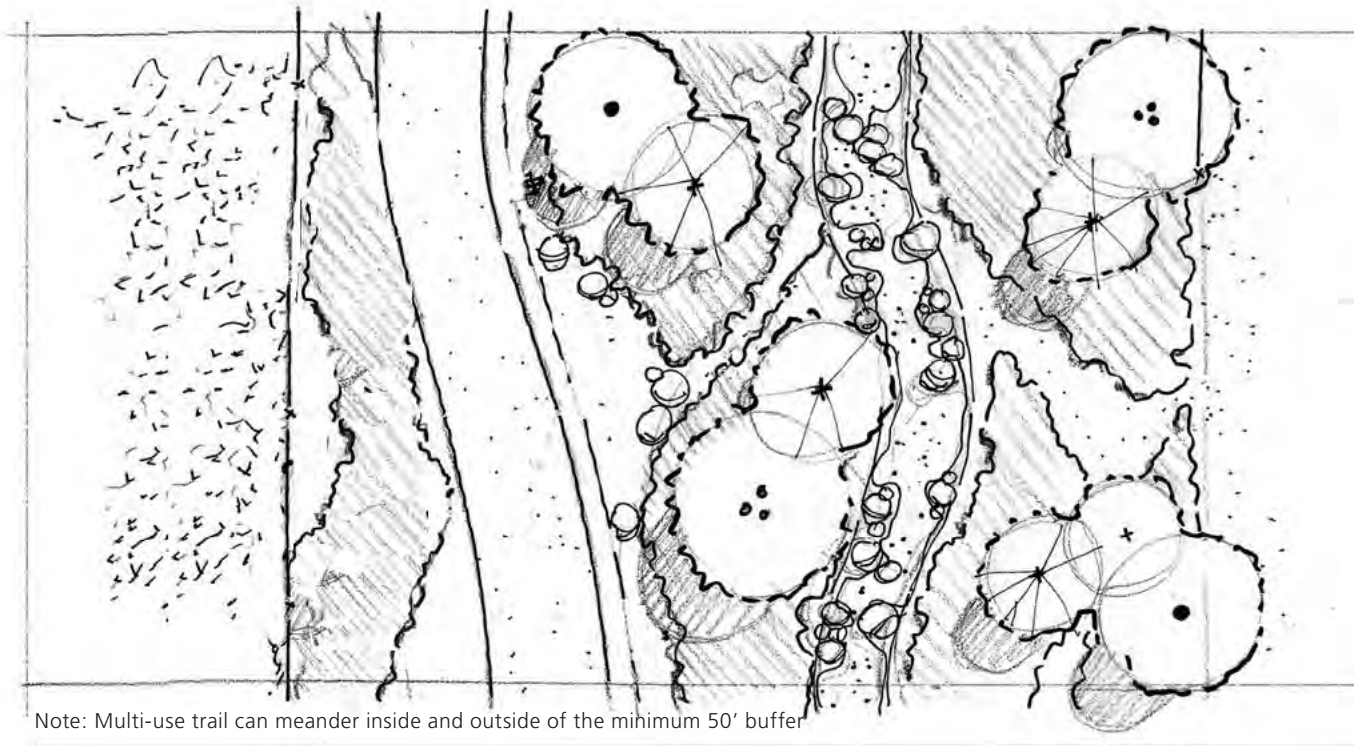
Conceptual Section and Vignette Location Map

Legend	
(A)	Park
(B1)	Mixed-Use
(B2)	Mixed-Use Common Space
(C)	Residential Side-On
(D)	Residential Front-On
(E)	Residential Back-On
(F)	Detention Basin
(G)	Paseo Central
(H)	Neighborhood Street / Arterial
(I)	Community Trail Through Avoided Area: At Grade
(J)	Community Trail Over Hydrological Connections (elevated)

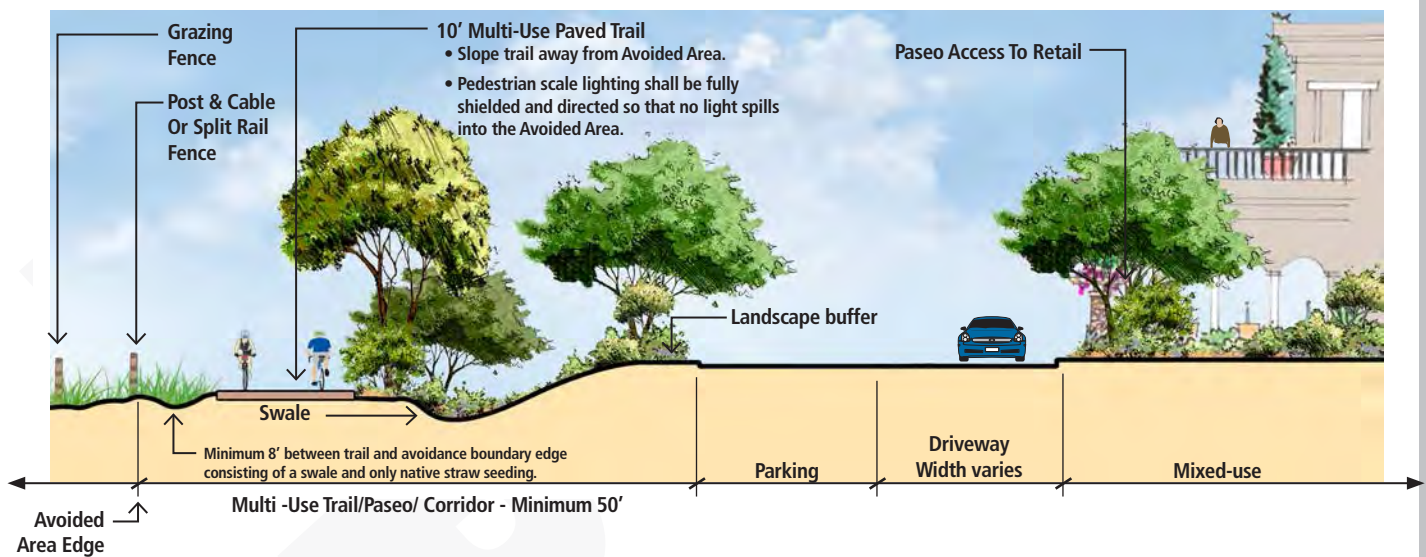
Note: Lettered Marker locations indicate potential locations in a generalized manner.



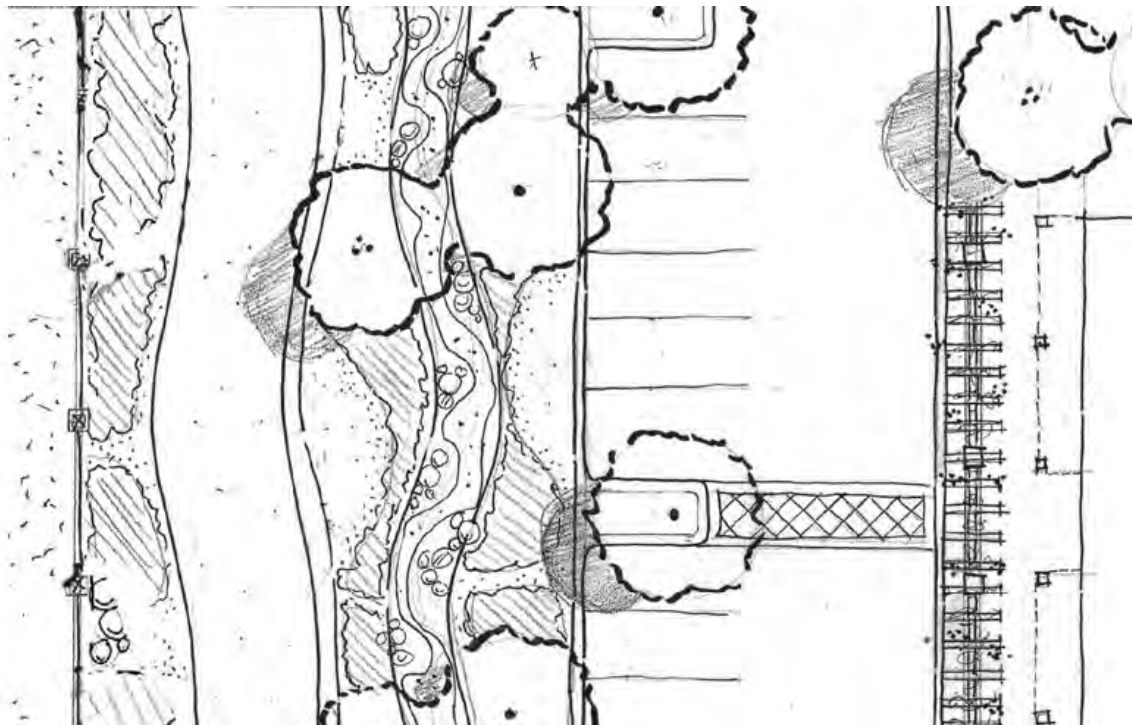
Edge Condition "A" Section
Sports Park



Edge Condition "A" Vignette
Sports Park

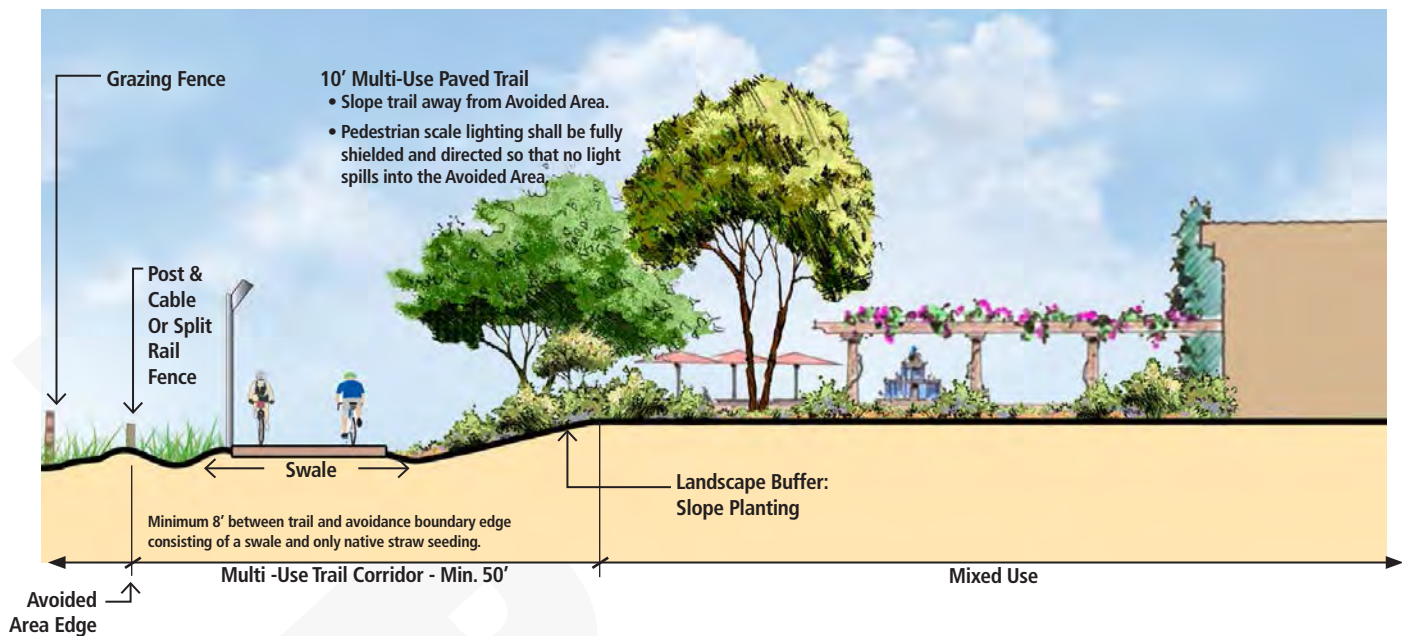


Edge Condition "B1" Section
Retail / Mixed Use

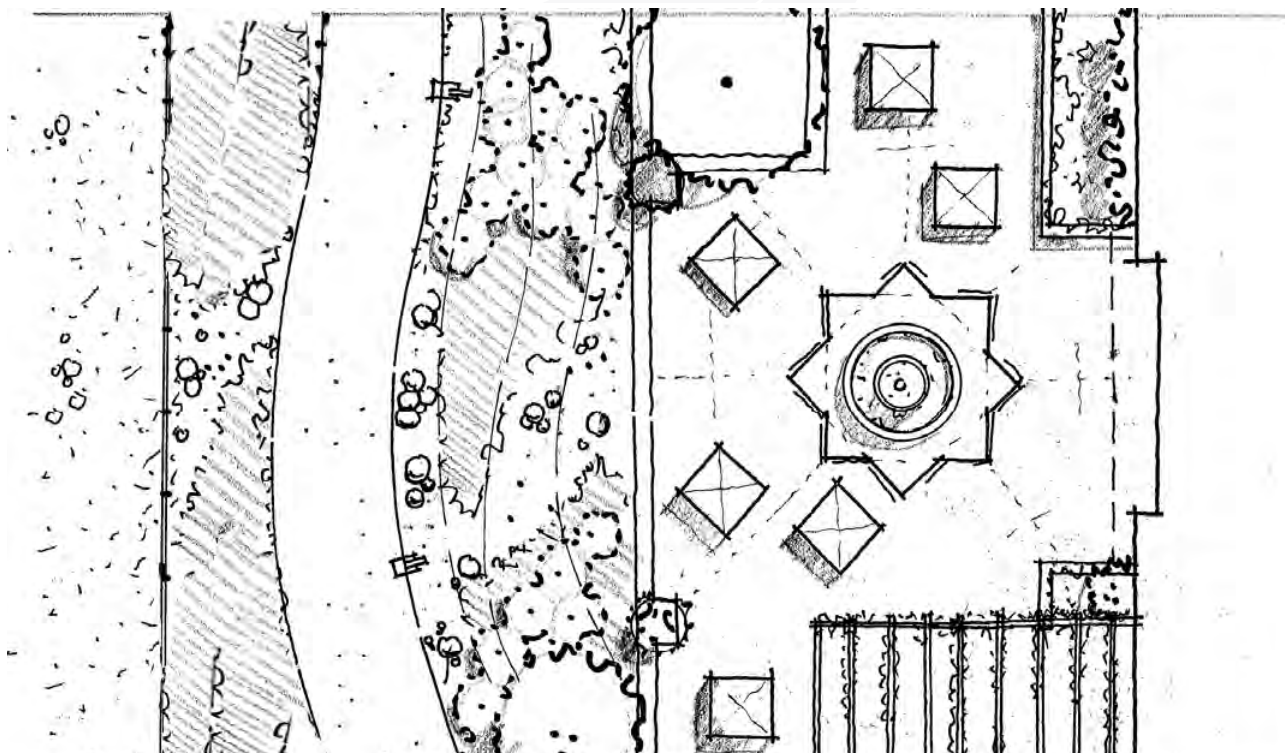


Note: Multi-use trail can meander inside and outside of the minimum 50' buffer

Edge Condition "B1" Vignette
Retail / Mixed Use

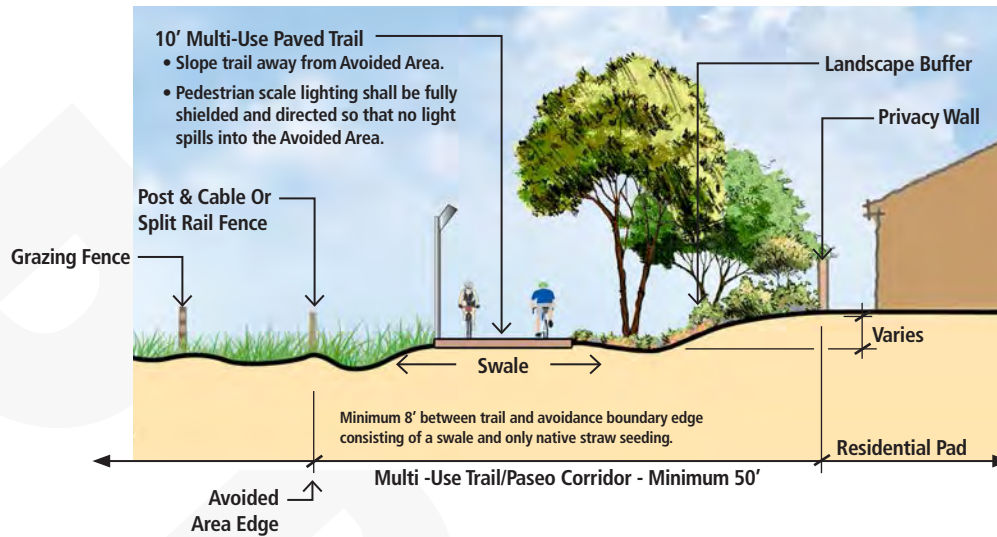


Edge Condition "B2" Section
Retail / Mixed Use Common Space



Note: Multi-use trail can meander inside and outside of the minimum 50' buffer

Edge Condition "B2" Vignette
Retail / Mixed Use Common Space

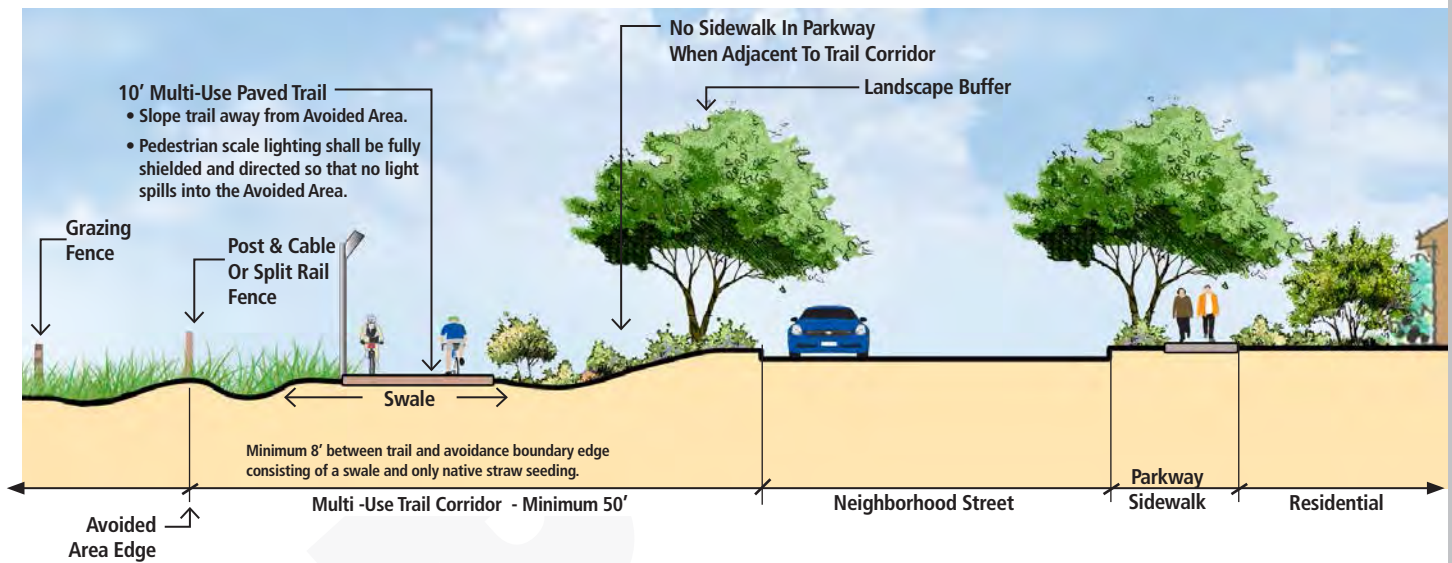


Edge Condition "C" Section
Residential Side-On

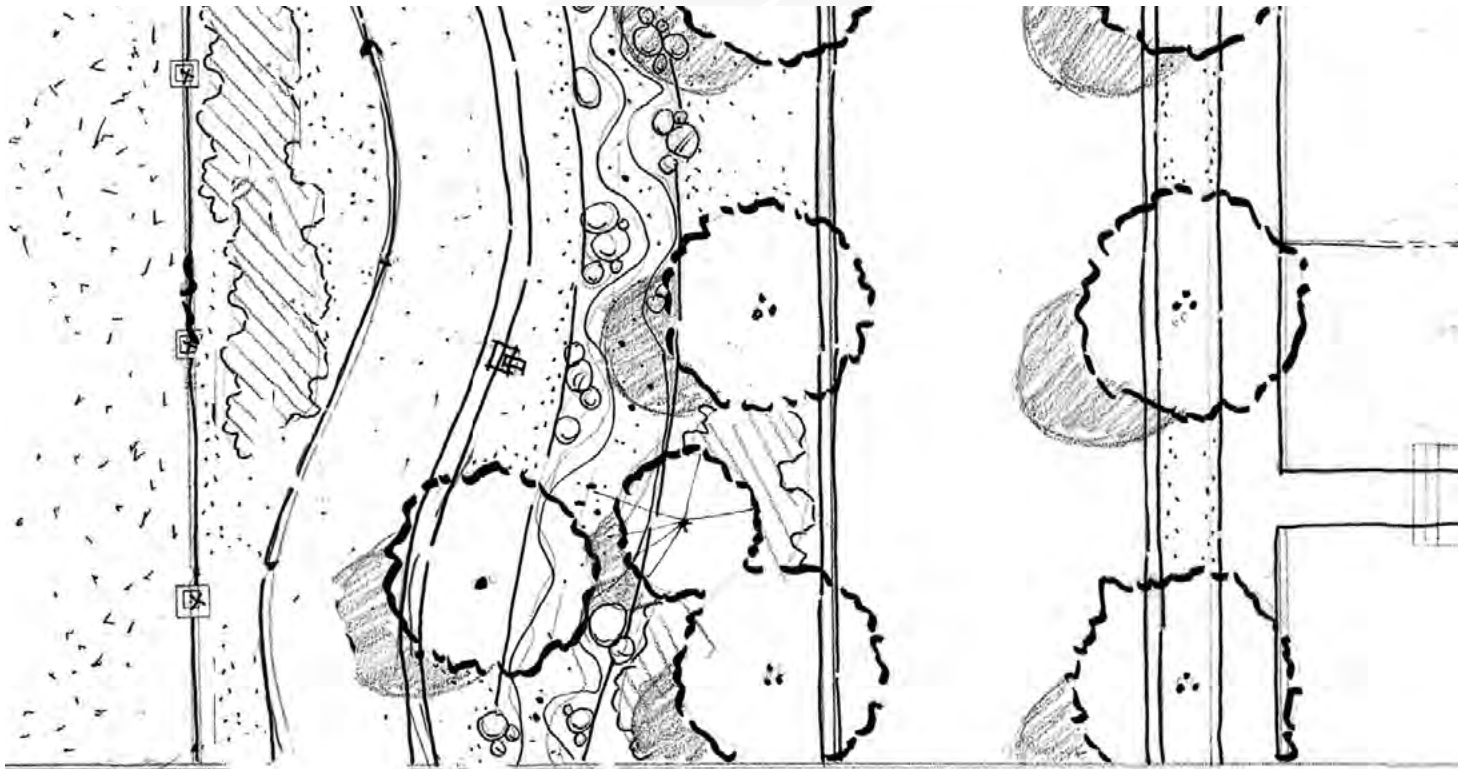


Note: Multi-use trail can meander inside and outside of the minimum 50' buffer

Edge Condition "C" Vignette
Residential Side-On

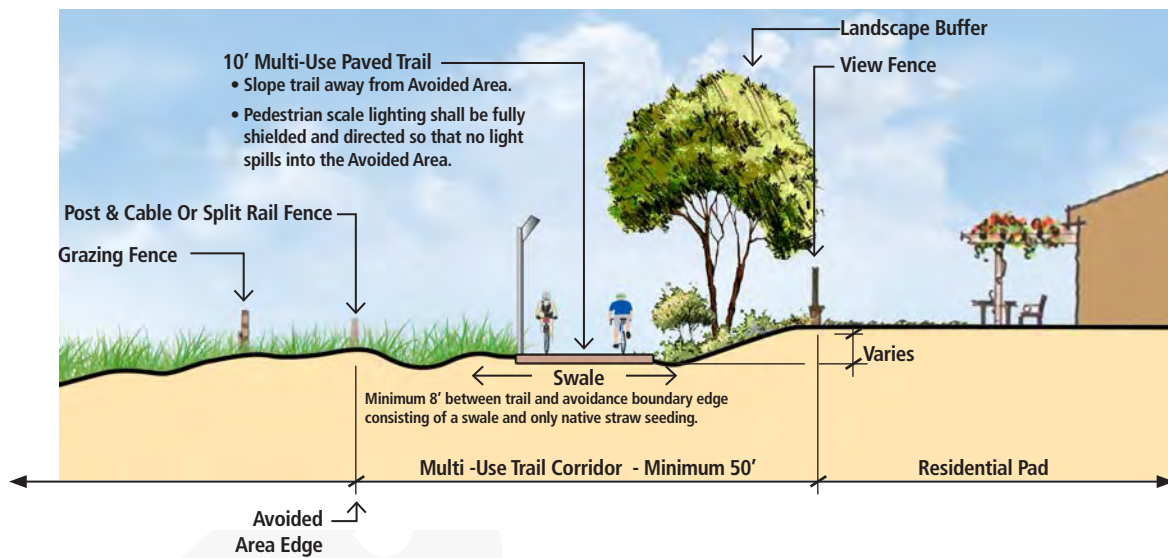


Edge Condition "D" Section
Residential Front-On With Street



Note: Multi-use trail can meander inside and outside of the minimum 50' buffer

Edge Condition "D" Vignette
Residential Front-On With Street

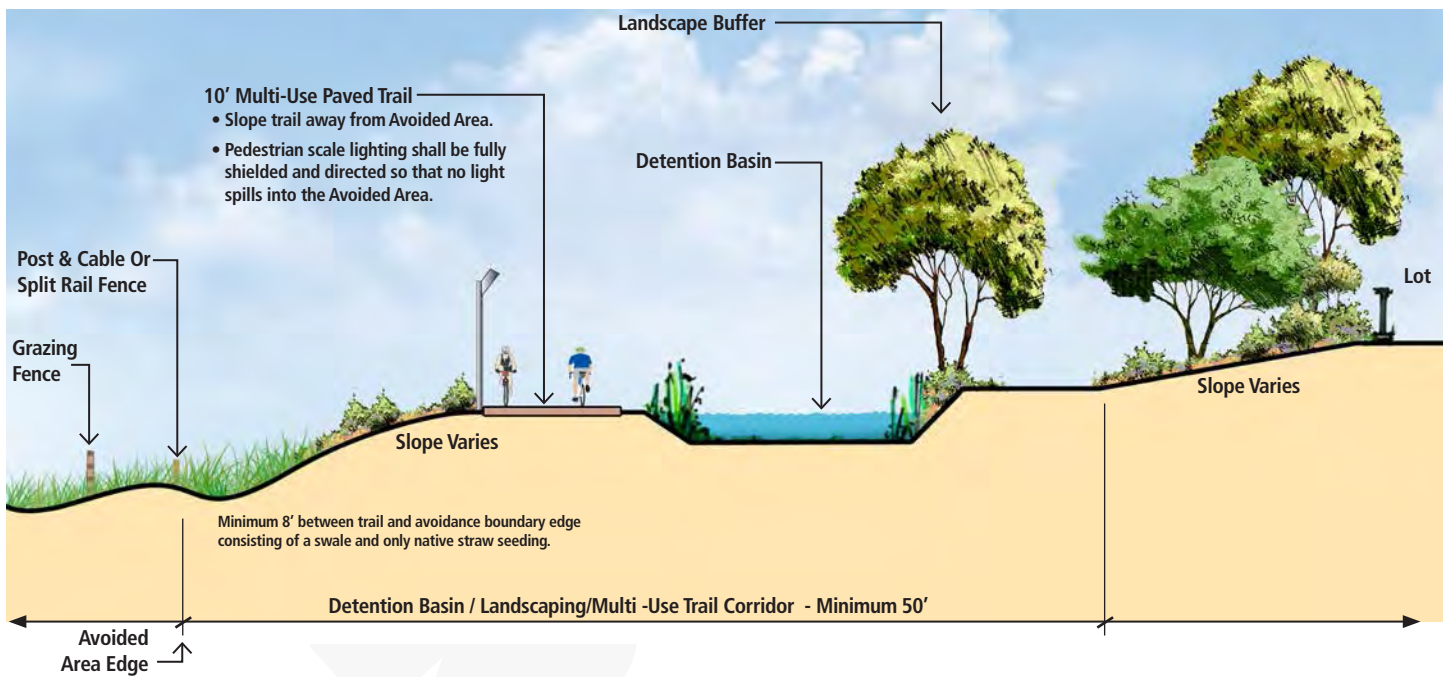


Edge Condition "E" Section
Residential Back-On



Note: Multi-use trail can meander inside and outside of the minimum 50' buffer

Edge Condition "E" Vignette
Residential Back-On

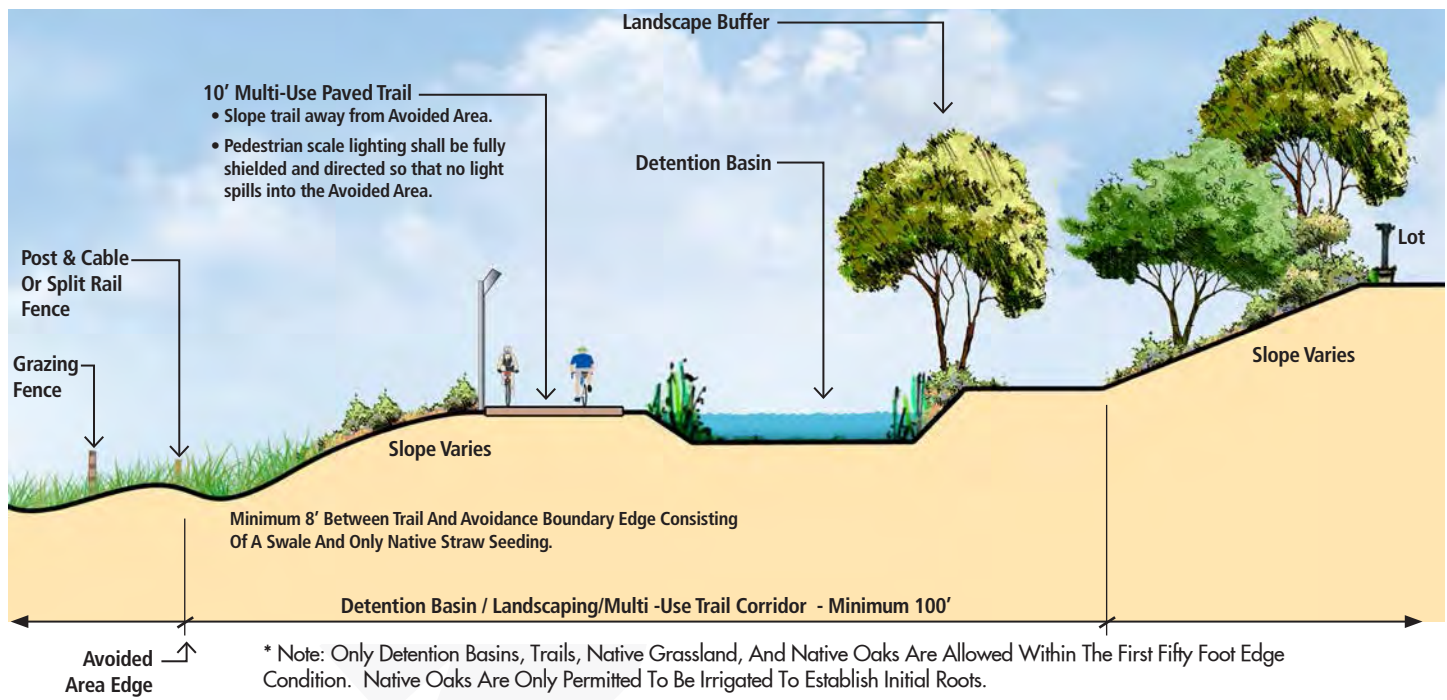


Edge Condition "F" Section
Detention Basin (Town Center)



Note: Multi-use trail can meander inside and outside of the minimum 50' buffer

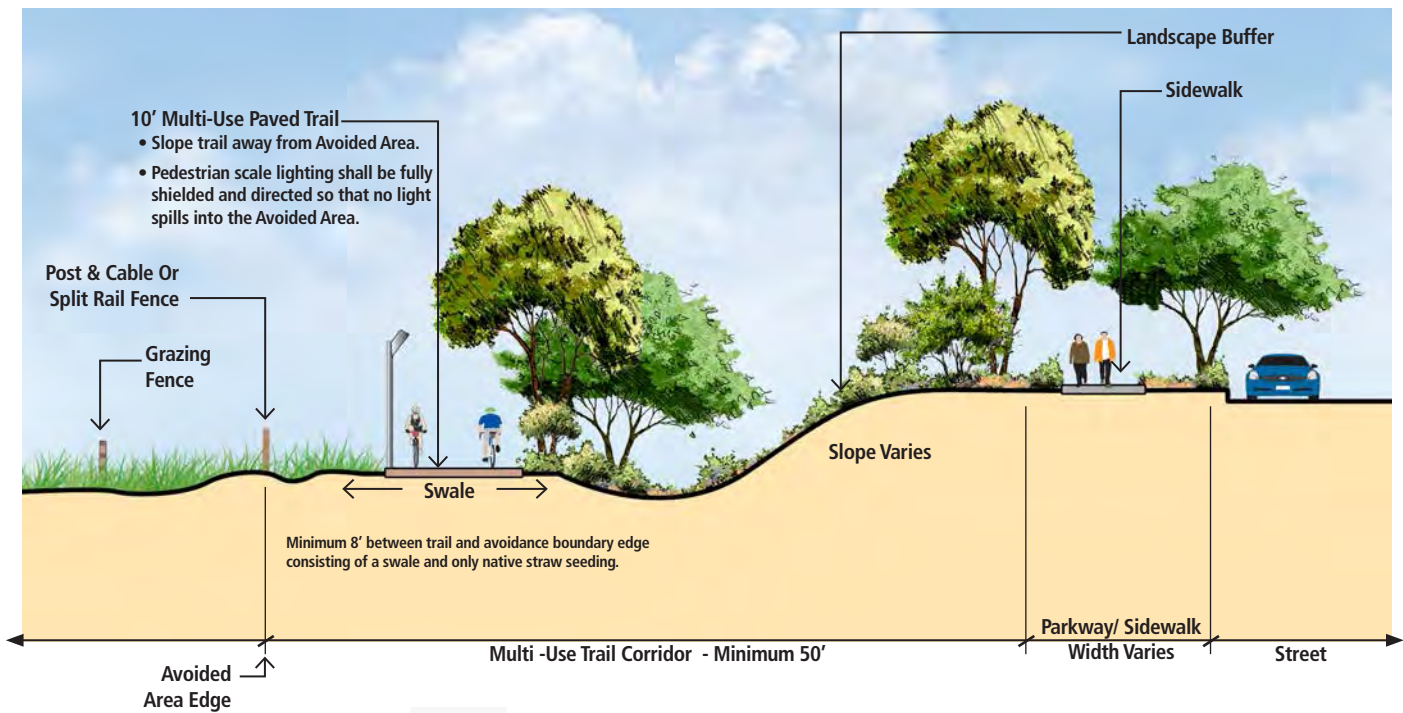
Edge Condition "F" Vignette
Detention Basin (Town Center)



Edge Condition "G" Section
Paseo Central



Edge Condition "G" Vignette
Paseo Central

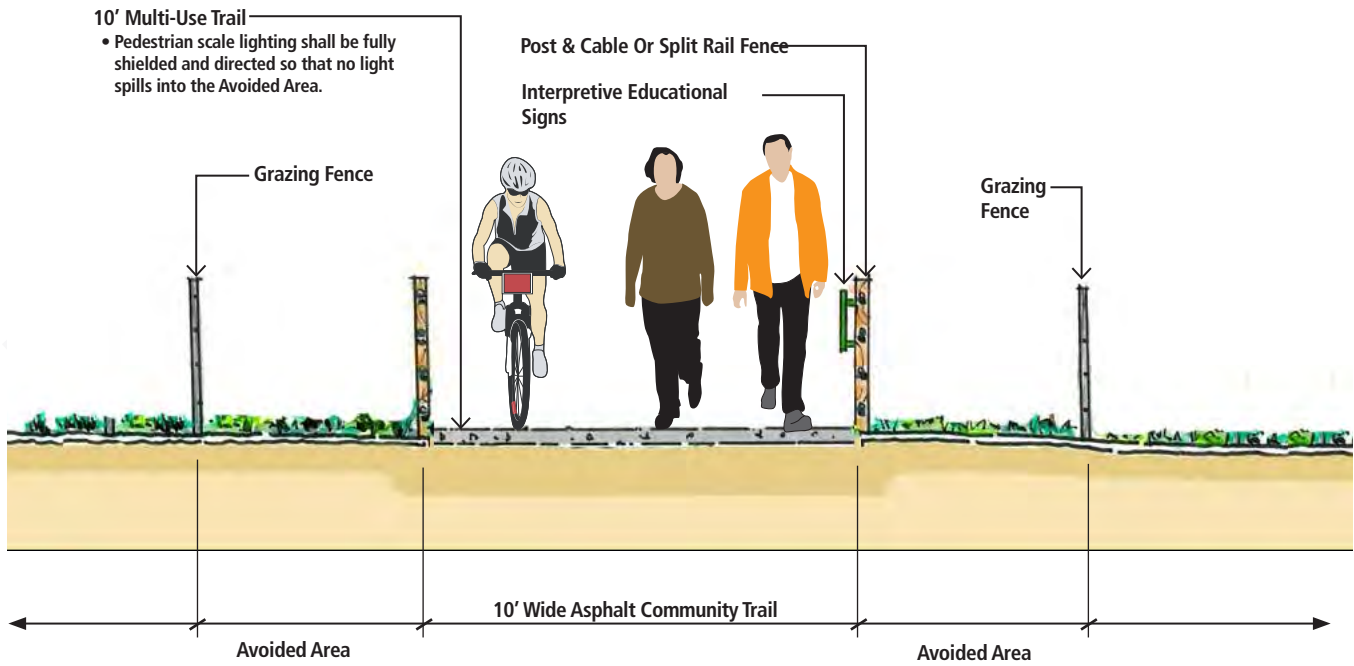


Edge Condition "H" Section
Neighborhood Street / Arterial

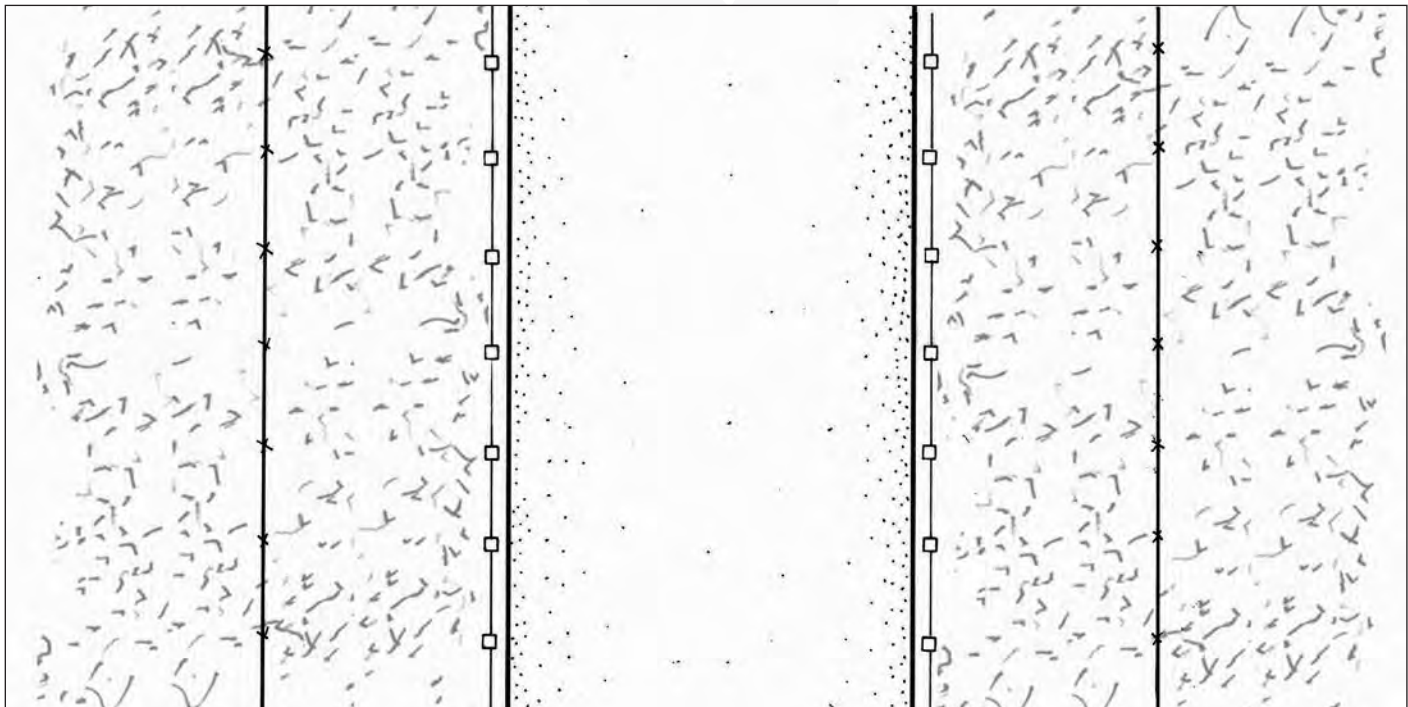


Note: Multi-use trail can meander inside and outside of the minimum 50' buffer

Edge Condition "H" Vignette
Neighborhood Street / Arterial

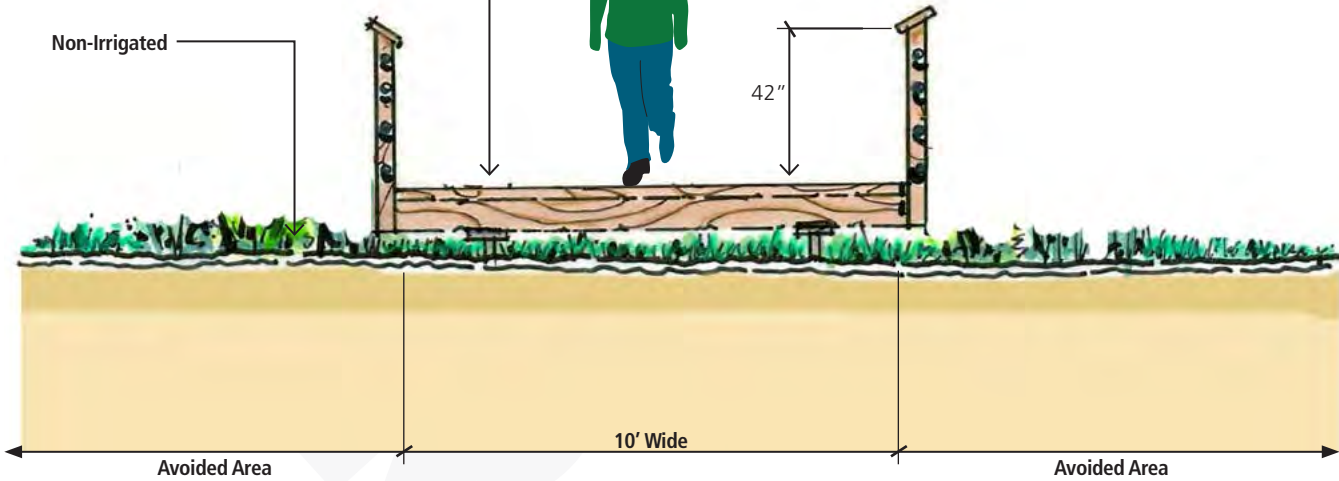


Edge Condition "I" Section
Community Trail Through Avoided Area: At Grade

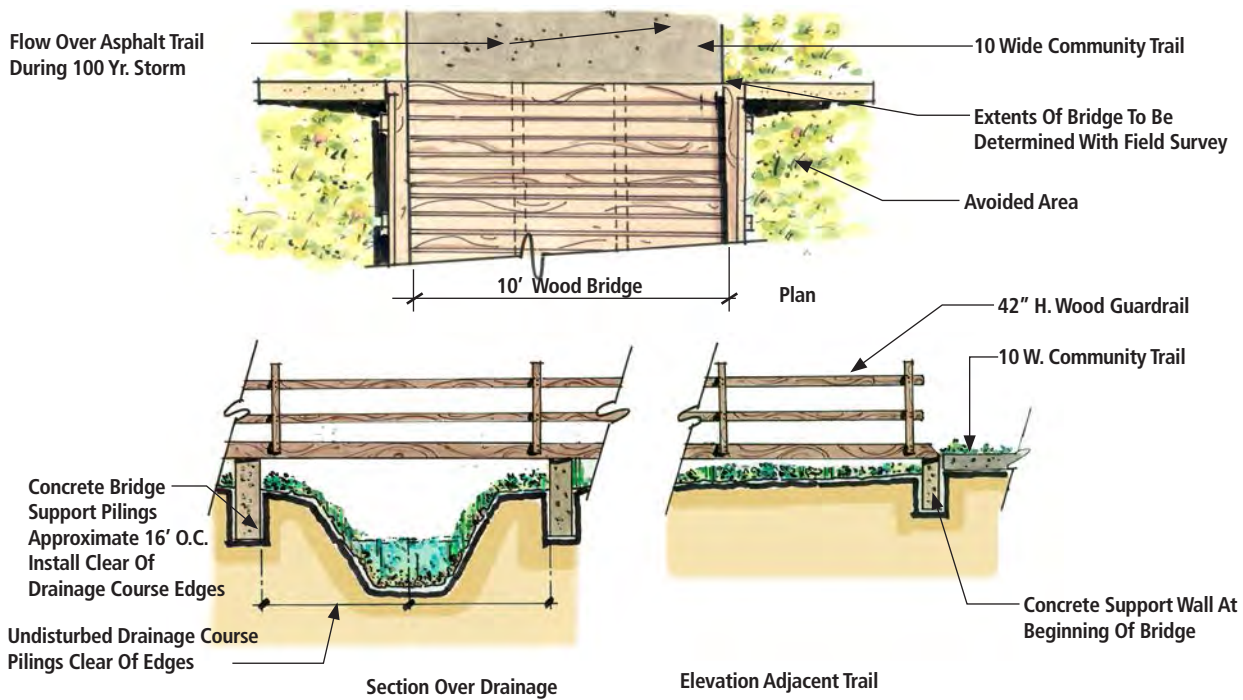


Edge Condition "I" Vignette
Community Trail Through Avoided Area: At Grade

- 10' Multi-Use Elevated Trail**
- Pedestrian scale lighting shall be fully shielded and directed so that no light spills into the Avoided Area.
 - Used Only To Cross Swales And Does Not Cross Any Vernal Pool Features



Edge Condition "J" Section Community Trail Over Hydrological Connections (elevated)



Edge Condition "J" Vignette Community Trail Over Hydrological Connections (elevated)

ATTACHMENT B

Refinements to the Mather Core Area at Cordova Hills



MEMORANDUM

TO: Mark Hanson / Cordova Hills, LLC.

FROM: Ben Watson / ECORP Consulting, Inc.

DATE: 7 August 2013

RE: *Refinements to the Mather Core Area at Cordova Hills*

A portion of the Mather Core Recovery Area (MCA), as defined in the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2005), is located on the Cordova Hills project site. In reviewing the polygon of the current MCA, there does not appear to be consistency in the existing MCA boundary based on topography, wetland type/density, watersheds, geology, or soil types. As such, it appears that the MCA boundary on the Cordova Hills site was originally drawn on a small scale map prior to the advent of high quality digital mapping analysis tools, and was never refined to reflect biotic or abiotic conditions on the ground.

In an attempt to determine what was intended for inclusion in the MCA, we reviewed the description of the MCA in the documents that reference it. The only thorough description we identified was located in the *Vernal Pool Tadpole Shrimp 5-Year Review* (USFWS 2007):

Prior to urban development, vernal pools in the Mather core area of Southeastern Sacramento Valley were hydrologically connected during high rainfall years. Vernal pools in this area exist in a "sub-watershed" matrix, roughly delineated by Highway 50 to the north and the Cosumnes River to the south. High rainfall leads to surface flooding, which connects old terrace vernal pools into large, shallow, slow-flowing, temporary lakes. This hydrologic system of connectivity during flooding supports the metapopulation dynamic of recolonization of vernal pools that are subject to localized extirpation during drought years. The hydrological connectivity in this area comprises a functioning ecosystem, underlain by old terrace soils, that is characterized by one of the densest and highest quality vernal pools areas in California (Service 2007; C. Witham, CNPS, pers. comm., 2007; R. Radmacher, Sacramento County, pers. comm., 2007).

The emphasis in this description appears to be on both the hydrologic connectivity of vernal pools and the presence of old terrace soils. ECORP Consulting, Inc. (ECORP) reviewed available hydrology and soils data, and conducted additional biological surveys in an attempt to refine the MCA boundary to better reflect the existing biotic and abiotic conditions at Cordova Hills. The results are described below, and we believe that this information supports a Refined Mather Core Area (RMCA) boundary at the Cordova Hills site (Figure 1).

Hydrologic Connectivity

While vernal pools in complexes throughout California have some degree of connectivity, the vernal pools on the western terrace of Cordova Hills have a high degree of connectivity, and interconnectivity, not found on many other sites in the region. The western terrace of the Cordova Hills project site is within the Laguna Creek watershed, which flows to the Sacramento River, while the remainder of the site is in the Carson Creek and Deer Creek watersheds, which flow to the Cosumnes River (Figure 1). Due to this significant watershed break, the western terrace vernal pools, while connected to vernal pools west of the project boundary, lack hydrologic and geologic connectivity with features on the eastern portion of the site. It appears that the boundary of the MCA might have been more appropriately drawn as terminating at this watershed break, which also closely corresponds to the extent of the Laguna Formation soils on-site.

Geology

The western terrace of Cordova Hills seems to be consistent with soil horizon characteristics of “old terrace” restrictive layers. The western terrace is comprised exclusively of one geologic unit – the Laguna Formation, which is the oldest alluvially-deposited surface in the Central Valley (CNPS 2009). The remaining geologic units on-site are Mehrten Formation, Valley Springs Formation, Lower Modesto Formation, and Gopher Ridge Volcanics. The Mehrten Formation is derived from volcanic mudflow deposits, the Valley Springs Formation is derived from volcanic ash flow deposits, the Lower Modesto Formation is comprised of recent alluvial deposits, and the Gopher Ridge Volcanics are comprised of metamorphic rocks. The Laguna Formation is clearly the only geologic formation on-site that fits the description of “old terrace.” Furthermore, 73% of the greater MCA occurs on the Laguna Formation. Although there are a few pockets of Laguna formation on the Cordova Hills project site east of the western terrace, the majority corresponds with the watershed break discussed above (Figure 1).

Biology

In 2009, ECORP conducted a California Rapid Assessment Method (CRAM) analysis of a subset of wetlands at Cordova Hills in order to determine their relative habitat quality values. A total of 24 Assessment Areas (AA) were identified, and the AA's that received the highest scores were located on the western terrace. The average CRAM scores for the MCA were 80.7, and the average CRAM scores for the RMCA were 84.7 (out of a possible 100) (Figure 2).

ECORP biologists conducted assessment level wet season surveys for large vernal pool branchiopods during the 2012-2013 wet season. During surveys, approximately 50% of all depressional wetlands (vernal pools and seasonal wetlands) and 100% of ephemeral and intermittent drainages were surveyed once. In addition, 41 vernal pools and seasonal wetlands east of the western terrace (and the RMCA) were subsequently targeted for protocol-level dry season surveys. These wetlands were selected, in consultation with Mr. Terry Adelsbach of the U.S. Fish and Wildlife Service, because they appeared to provide the highest quality habitat for listed vernal pool branchiopods east of the western terrace.

All vernal pool tadpole shrimp (*Lepidurus packardii*) identified during surveys were located within the RMCA, and all but six (83%) of the vernal pool fairy shrimp (*Branchinecta lynchi*) occurrences were located within the RCMA. No listed vernal pool branchiopod cysts were detected during dry season surveys outside of the RMCA (Figure 3). Rare plant surveys were conducted throughout the Cordova Hills site in 2007 and 2008, and Sacramento Orcutt grass was detected in two vernal pools in the northeastern corner of the RMCA. The results of the rare plant surveys, the vernal pool branchiopod surveys, and the wetland CRAM scores support the premise that the highest quality wetlands within the Cordova Hills site occur in the RMCA, and that the habitat for listed species to the east is much different and of lower value than the habitat located in the RMCA.

Conclusion

While it appears that the MCA boundary was intended to be defined based on the hydrologic connectivity of the vernal pools in the region, as well as by soil type, the actual boundary appears to include topography, soil types and upland habitat not consistent with the objectives of MCA preservation goals. Based on mapped soil types, watershed breaks, wetland CRAM scores, and survey data for federally listed species on the Cordova Hills site, it appears that the RMCA boundary is a more valid representation of what the MCA boundary was intended to be.

Literature Cited:

California Native Plant Society (CNPS). 2009. Vernal Pool Geology. Published by the Sacramento Valley Chapter of the California Native Plant Society at: <http://www.sacvalleycnps.org/conservation/vernalpools/mather3.htm>

U.S. Department of the Interior, Fish and Wildlife Service (USFWS). 2005. Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon. Dated 15 December 2005.

U.S. Department of the Interior, Fish and Wildlife Service (USFWS). 2007. Vernal Pool Tadpole Shrimp (*Lepidurus packardii*), 5-Year Review: Summary and Evaluation. Sacramento Fish and Wildlife Office, Sacramento, California. Dated September 2007.

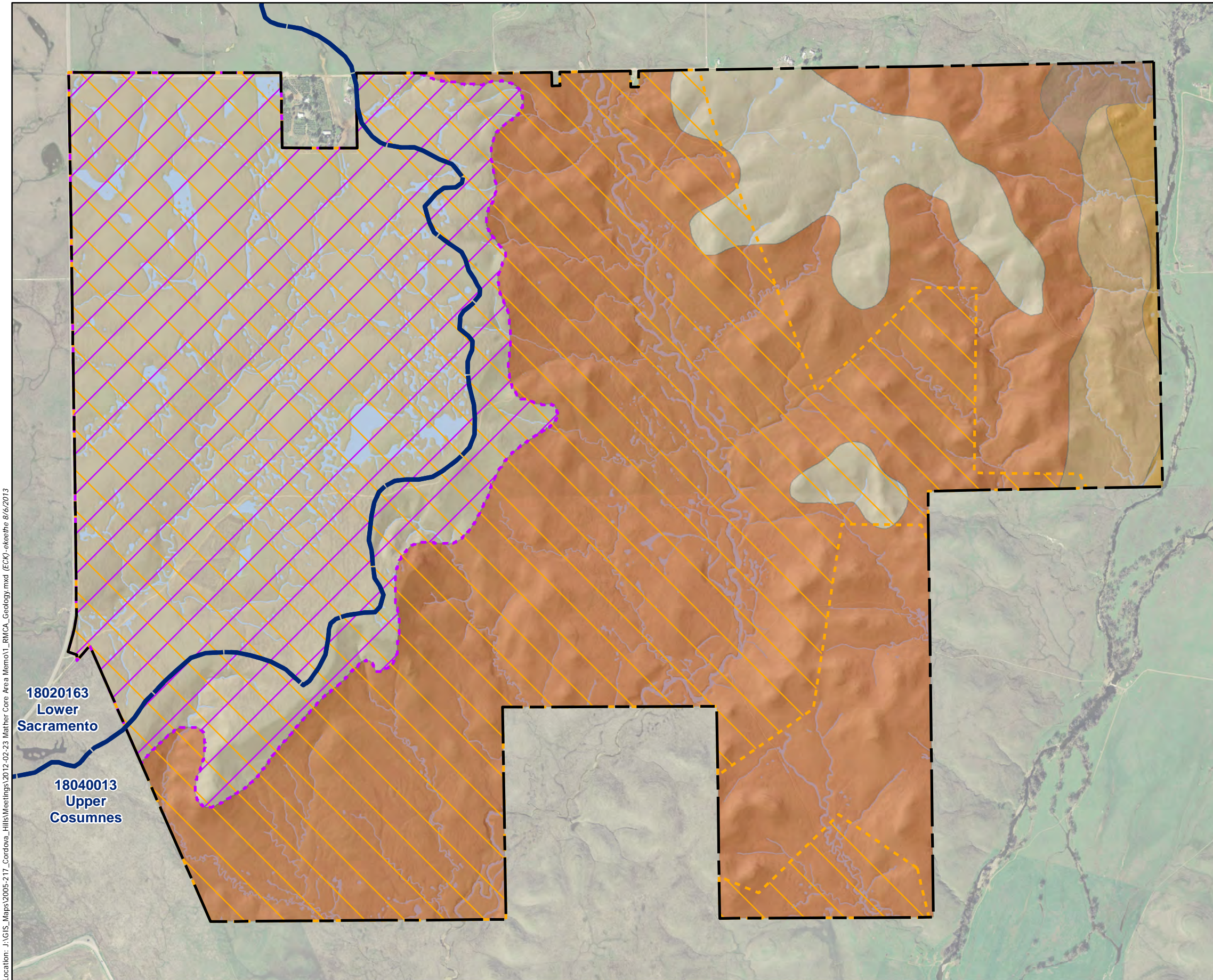












Figure 1.
Cordova Hills - Mather Core Areas

Map Features

-  Project Boundary
-  Wetlands
-  Mather Core Area from Recovery Plan (2,015 acres on-site)
-  Refined Mather Core Area (905 acres on-site)
-  HUC 08 Boundary

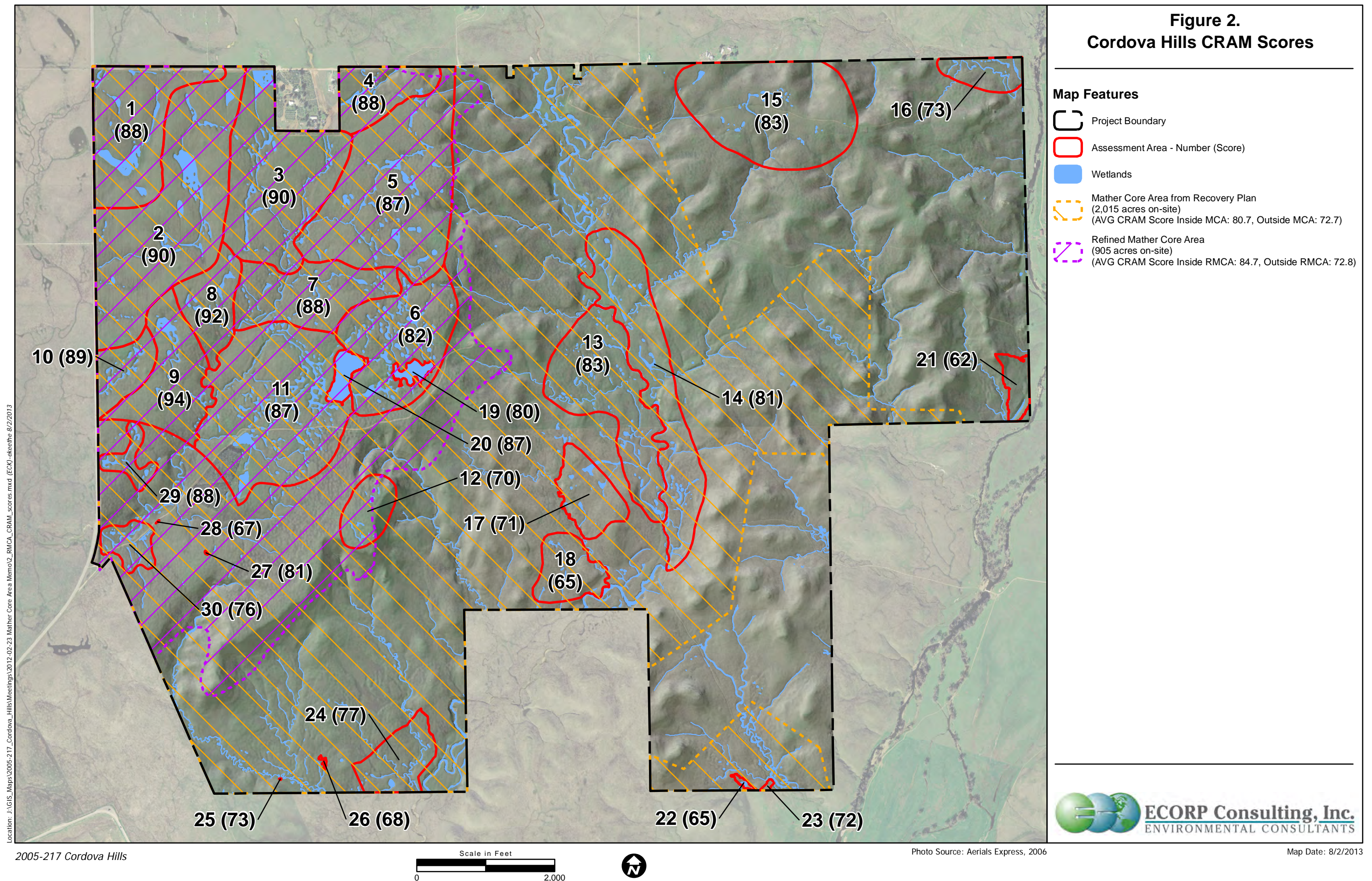
Geologic Features

-  Jgo - Gopher Ridge Volcanics: 21 ac. on-site
-  Qm2 - Lower Modesto Formation (alluvium): 21 ac. on-site
-  Tl - Laguna Formation: 1087 ac. on-site
-  Tm - Mehrten Formation: 1451 ac. on-site
-  Tvs - Valley Springs Formation: 89 ac. on-site

Location: J:\GIS_Maps\2005-217_Cordova_Hills\Meetings\2012-02-23_Mather_Core_Area_Memo1_RMCA_Geology.mxd (ECK) eke@ecorp.com 8/6/2013



Figure 2.
Cordova Hills CRAM Scores



Location: J:\GIS_Maps\2005-217_Cordova_Hills\Meetings\2012-02-23_Mather_Core_Area_Memo\3_RMCA_ShrimpResults.mxd (ECK)-ekleehe 8/2/2013

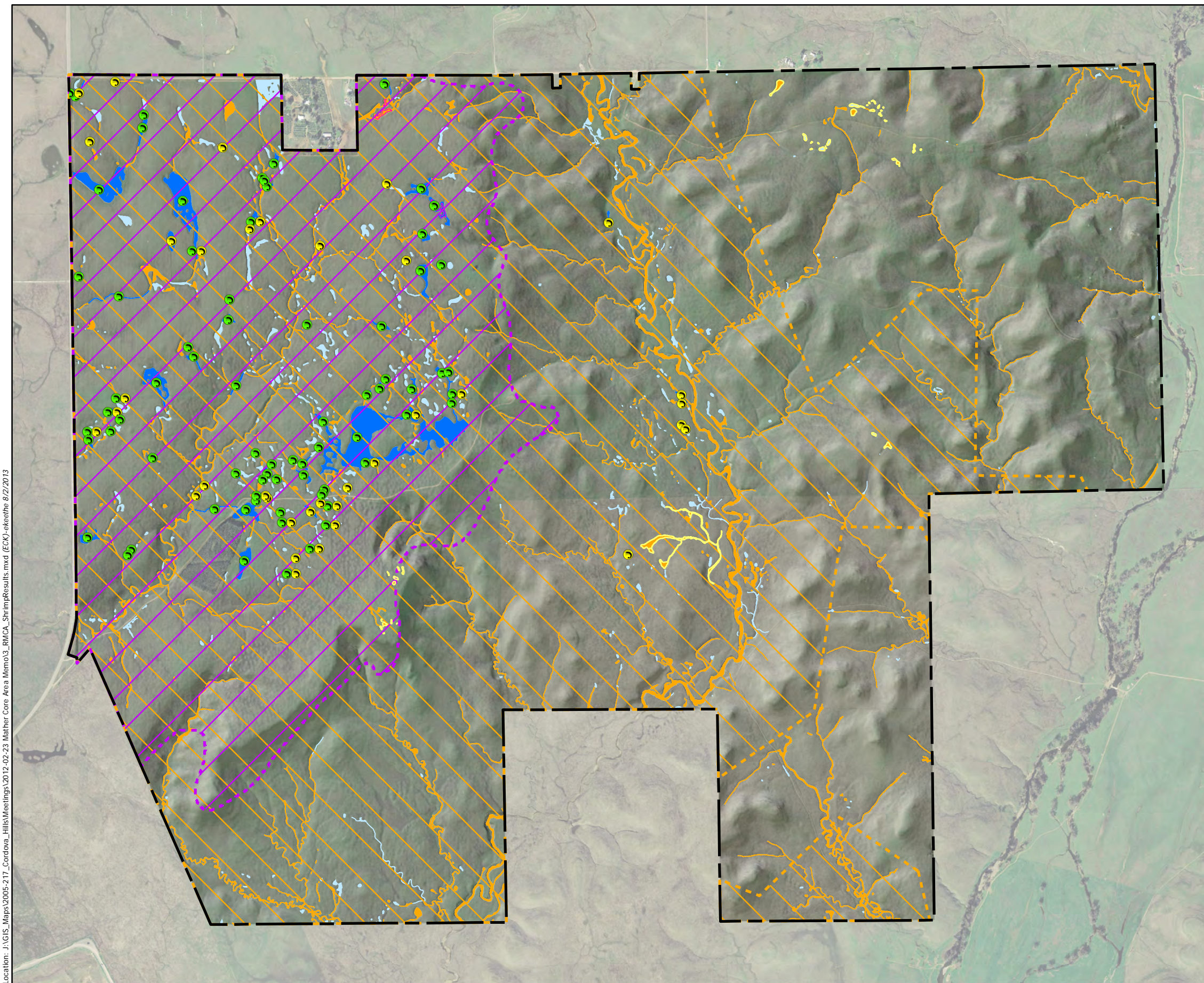












Figure 3.
Cordova Hills
Vernal Pool Crustacean
Survey Results

Map Features

-  Project Boundary
-  Non Surveyed Wetlands
-  Mather Core Area from Recovery Plan (2,015 acres on-site)
-  Refined Mather Core Area (905 acres on-site)
-  Sacramento Orcutt Grass
-  Dry Season Survey (Negative Results - All)
-  Wet Season Survey (Negative Results)
-  Wet Season Survey (Positive Results)

Wet Season Survey Results

-  *Lepidurus packardii*
-  *Branchinecta lynchi*



ATTACHMENT B

Vernal Pool Creation Plan

Site Evaluation, Hydrological Potential, and Conceptual Onsite Vernal Pool Creation Opportunities for the Cordova Hills LLC Property, Sacramento, California

Prepared for

Mark Hanson

Cordova Hills, LLC.

5241 Arnold Avenue

McClellan, CA 95652

Prepared by

Institute for Ecohydrology Research

2106 Saratoga Place

Davis, CA

95616

October 29, 2014

Summary

This report discusses the process of identifying potential locations within onsite preserves for onsite vernal pool mitigation through creation. The approach for identifying potential vernal pool mitigation sites followed the US Army Corps of Engineers Guidelines for site evaluation based on a “watershed” approach and using hydrology and soils as primary factors in the assessment of wetland mitigation. This report provides baseline information of the physical features at the site to identify areas that it is suitable based on hydrological and soil characteristics. Field measurements and analyses of existing, natural vernal pools were used as a model for potential mitigation pools. Natural topography and soil features were specifically used to identify how mitigation vernal pools could be created and experience hydrological functioning similar to existing natural vernal pools. With additional field data, there is potential to create mitigation vernal pools while not impacting the hydrology of the existing pools.

The report identified eleven areas covering 131 acres that have topographic and soil conditions suitable for the successful creation of vernal pools and swales. Within these eleven areas it was estimated between 6.55 acres and 13.1 acres of vernal pool and swale wetlands potentially could be created. This result is based on surveys of the surface topography and soil profiles. Those data were used to determine the landscape structure as a hydrological unit with local drainages supporting existing vernal pool and swales that drain into a larger drainage system. In addition, ground-penetrating radar surveys measured the density changes within the soil profiles of existing vernal pools and areas without vernal pools. This information was used to evaluate whether the soils have a water-restricting layer (duripan or clay rich horizon) required to support the seasonal water table. A table lists the potential for creating vernal pools onsite and identifies the potentials acres using a 5% and 10% wetland construction of the area. This is the maximum estimated acreage of seasonal wetlands and vernal pools that could be created without impacting existing wetlands. Additional study would define the actual acreage that could be created and would be dependent on the presence of existing wetlands. The presence of existing vernal pools containing rare and endangered species, including Sacramento Orcutt grass and federally-listed invertebrates, does create constraints on the feasibility of creating vernal pools in some areas without having direct or indirect impacts to those biological resources. Additional information needs are identified to be able to develop a detailed vernal pool compensatory mitigation creation plan for the site.

Introduction

This report is a site evaluation and suitability for determining the feasibility of creating vernal pool and other seasonal wetlands for the Cordova Hills LLC project property, Sacramento County, California (**Figure 1**). The purpose of this report is to provide a conceptual plan for creating vernal pools within an existing natural landscape that in some areas contains vernal pools, other wetland resources, and important endangered species of plants and invertebrates. The approach of the study the US Army Corps of Engineers' (USACOE) Mitigation and Monitoring Guidelines (December 30, 2004). Those guidelines state:

“The selection of a site with suitable hydrologic conditions has been one of the most neglected aspects of compensatory mitigation planning. The National Research Council’s *Compensating for Wetland Losses Under the Clean Water Act* (2001) stated that hydrological conditions, including variability in water levels and flow rates, are the primary driving force influencing wetland development, structure, functioning, and persistence.”

and

“Site selection should include and prioritize the following criteria:”

a. Natural Hydrology. The goal should be to have the aquatic feature be supported by a self-sustaining, natural hydrologic process requiring little or no long-term maintenance. It is recommended that the applicant compare hydrologic information at the compensatory mitigation site to similar reference (i.e., high-functioning) sites in the region, as well as to the impact site for design guidance.

c. Soil Characteristics. Many past compensatory mitigation projects did not address the development of suitable soils. Examination of soils at reference sites will provide important information on the target habitat. Thorough assessments of mitigation site soils should be conducted to determine the site’s suitability for supporting the target habitat. In the case of in-kind compensatory mitigation for wetlands, soils from the impacted aquatic habitat can be used at the compensatory mitigation site.”

Figure 1 Location of the Cordova Hills LLC Property



In addition, the objectives of this conceptual mitigation design plan were to create a vernal pool landscape that:

- Does not directly or indirectly negatively impact any existing vernal pools, other wetlands, and rare and endangered plant or animal species,
- Utilizes the natural topography and soils to enhance existing natural surface and subsurface water flow regimes resulting in vernal pool-swale complexes that in all respects mimic natural ones.

Methods

Background Information

Vernal pools are recognized as complex seasonal wetlands due to the structure of the soils and importance of the presence of soil depressions overlaying a shallow water-restricting layer (Hobson and Dahlgren 2001, Smith and Verrill 1998). The water-restricting layer, called a duripan for some specific types of soil horizons, is critical in the formation of a seasonal, perched water table (McCarten et al. 2009, Rains et al. 2006). The presence, depth, and topography of the water-restricting layer determine the hydrological functioning of individual vernal pools and their subsurface connectivity. The presence of the water-restricting layer is a requirement for soils in their consideration as potential sites for vernal pool restoration or creation.

The project site is the Cordova Hills LLC project property (**Figure 1**). A jurisdictional wetlands delineation verified by the USACOE (ECORP 2014) was used to identify existing wetland resources on the site. Information on the soils mapped for the site was obtained from Natural Resources Conservation Service Online Soil Survey 2014 (<http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx>). Information on rare and endangered species was from the invertebrate surveys conducted by ECORP (2013) and the California Department of Fish and Wildlife's Natural Diversity Database (<https://www.dfg.ca.gov/biogeodata/cnddb>). Current and historic aerial photos were viewed on Google Earth Professional (Google Earth 2014).

Field Surveys

Field surveys using Real Time Kinematic global positioning system (RTK GPS) and ground-penetrating radar (GPR) were conducted September 24, 26 and 27 and October 1 and 16-19, 2014.

Real Time Kinematic Global Positioning System

A Trimble R8 RTK GPS was used to survey the property in order to make high resolution (spatial precision of ± 1 cm, elevation ± 2 cm) topographic maps. This level of precision is needed to accurately measure relationships between vernal pool elevation gradients, soil horizons and surface and subsurface

hydrology. The survey provides a baseline for the overall property upon which more detailed RTK GPS surveys can add to the existing data to develop a grading plan. The current survey included the full elevation range of the property except for the creek. This survey provided sufficient information to identify the local catchments occupied by existing vernal pools and areas that could be potential vernal pool mitigation creation sites.

Ground-Penetrating Radar

The GPR was used to conduct a non-destructive survey of the soil profile to evaluate the presence, continuity, and topography of soil horizons that form a water-restricting layer. A MALÅ Geosciences GPR system using an 800 MHz shielded antenna with a cart to measure distance was used to conduct the field surveys. The GPR transects ranged in length from about 200 feet to 1,000 feet. Transects were made to include all elevations, excluding the creek, elevation gradients from upland to the creek or lowest point. Specific transects were made across existing natural vernal pools and swales to determine the variation in depth and continuity of water-restricting soil layers from the uplands through the pool soil depression and along swales.

The data collected were organized and analyzed in a step-wise process to understand the physical structure of the landscape that frames the hydrological unit in terms of the overall catchment structure, surface topography, and microshed subunit contributions. The components were characterized by maps and a digital elevation model. Existing wetland features were then overlain onto the landscape to understand the natural setting of wetlands, their connectivity, and drainage patterns. Soil profiles from the GPR transects identified the subsurface parameter needed for vernal pools and seasonal wetlands and swales.

Identifying potential areas of vernal pool and swale creation was done by studying how the natural vernal pools and swales were structured in the landscape. In general, areas with low ($< 2\%$) elevation gradient within a drainage system or following a contour and with an up slope catchment had vernal pools and swales. In addition, areas having a water-restricting layer such as duripan were integral to vernal pools that function hydrological in average, above average, and below average rainfall years.

Results

Figure 2 shows part of the Cordova Hills LLC property and the primary area of the evaluation and suitability study. The RTK GPS and GPR surveys were conducted primarily within the Draft Environmental Impact Statement Preserve Areas highlighted in **Figure 2** and showing the existing wetlands. **Figure 3** shows the study area overlain on a contour layer with one-foot contour intervals. The elevations range from about 220 feet above mean sea level (msl) to approximately 265 feet msl. A digital elevation model of the site (**Figure 4**) shows there is a primary drainage flowing from northeast to southwest. The Preserve boundary line (**Figure 4**) identifies the majority of the preserve area on the east slope of the drainage.

Figure 2 Map of the Cordova Hills Property Showing the Boundary of the EIR Preserve Area with Existing Wetlands

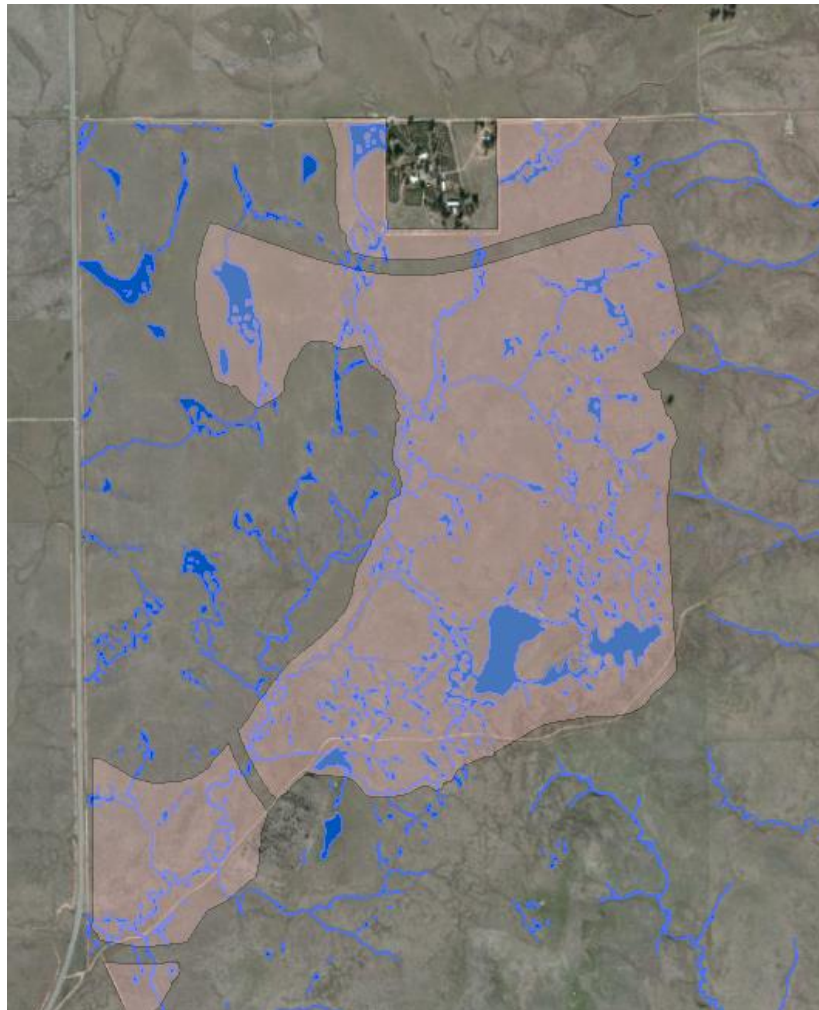


Figure 3 Cordova Hills Showing Preserve Boundary and Existing Wetlands Overlain on Elevation Contour

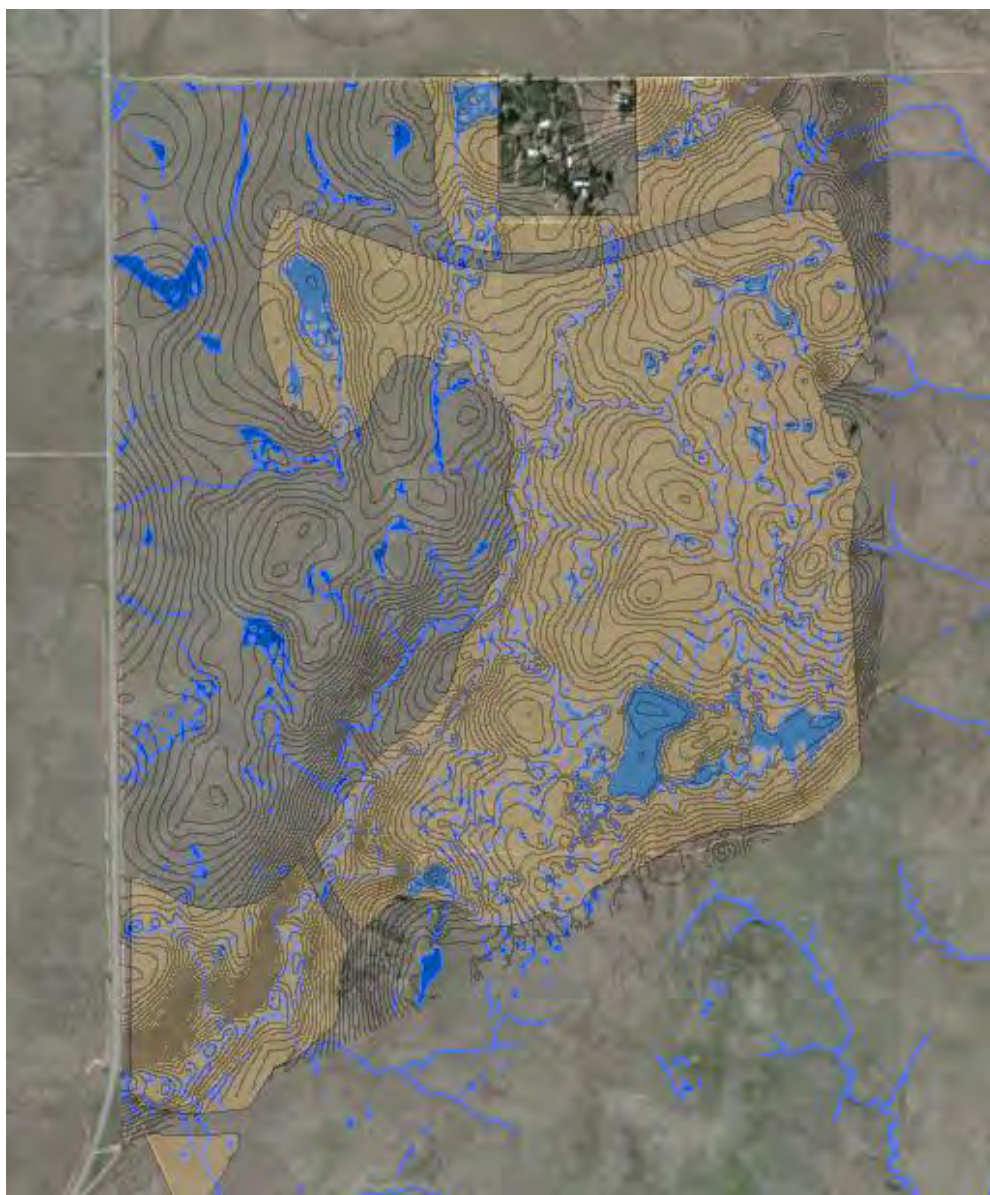


Figure 4 Digital Elevation Model of the Watershed for Cordova Hills. Approximate Boundary of Preserve Shown in Red. Primary Drainage Flows South Southwest.

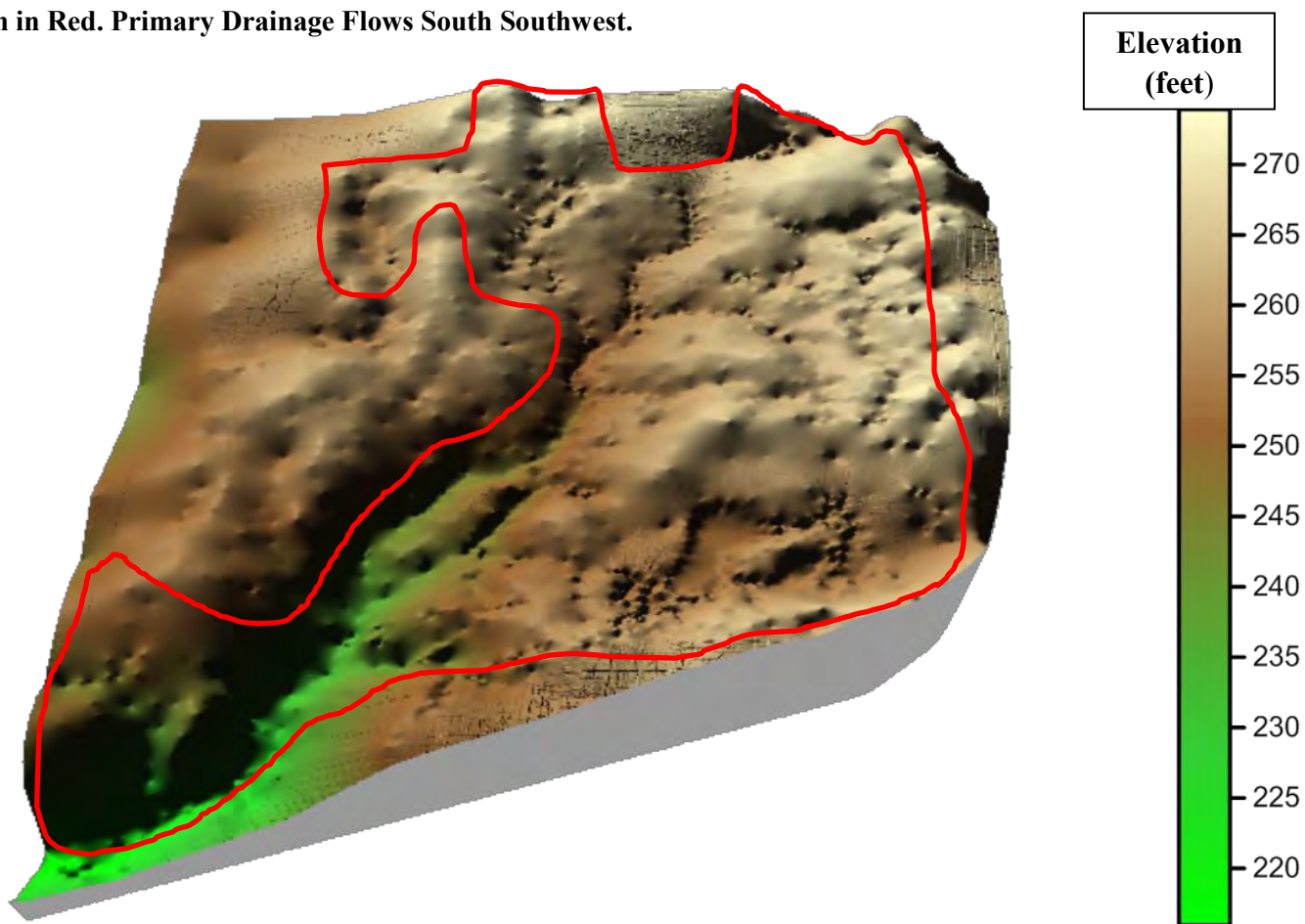
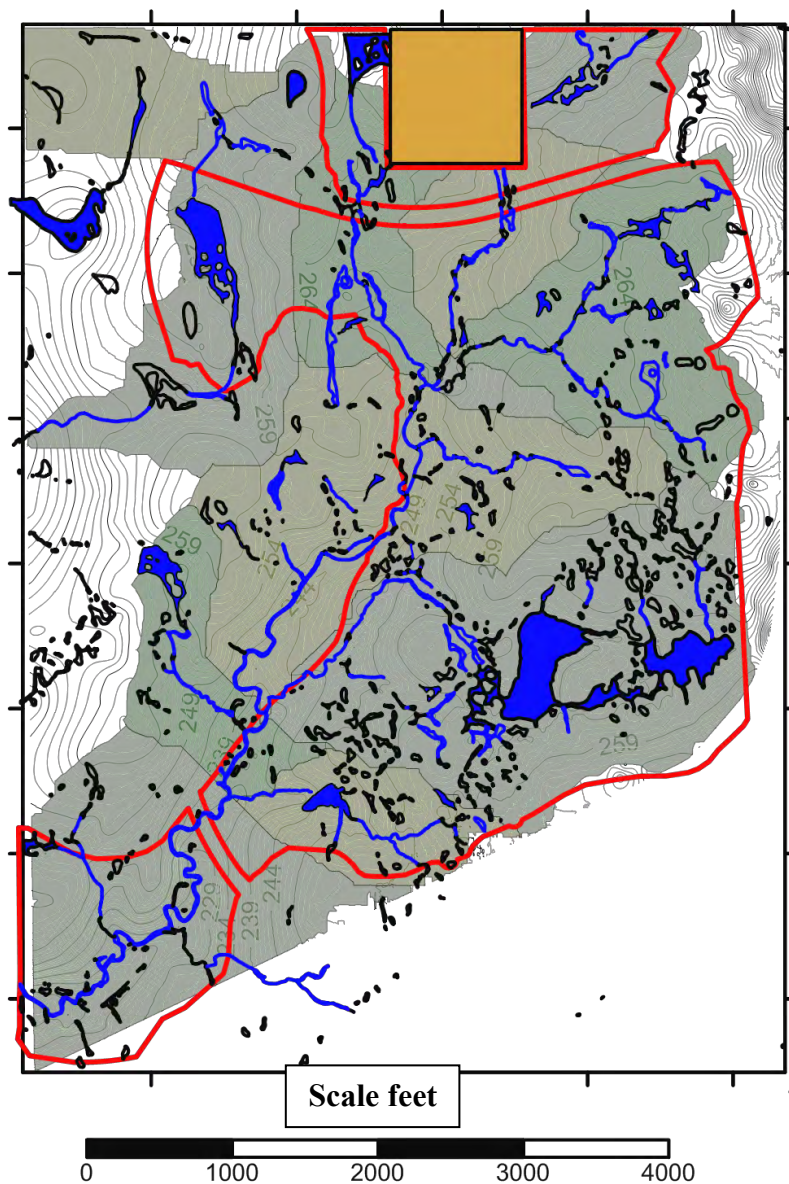


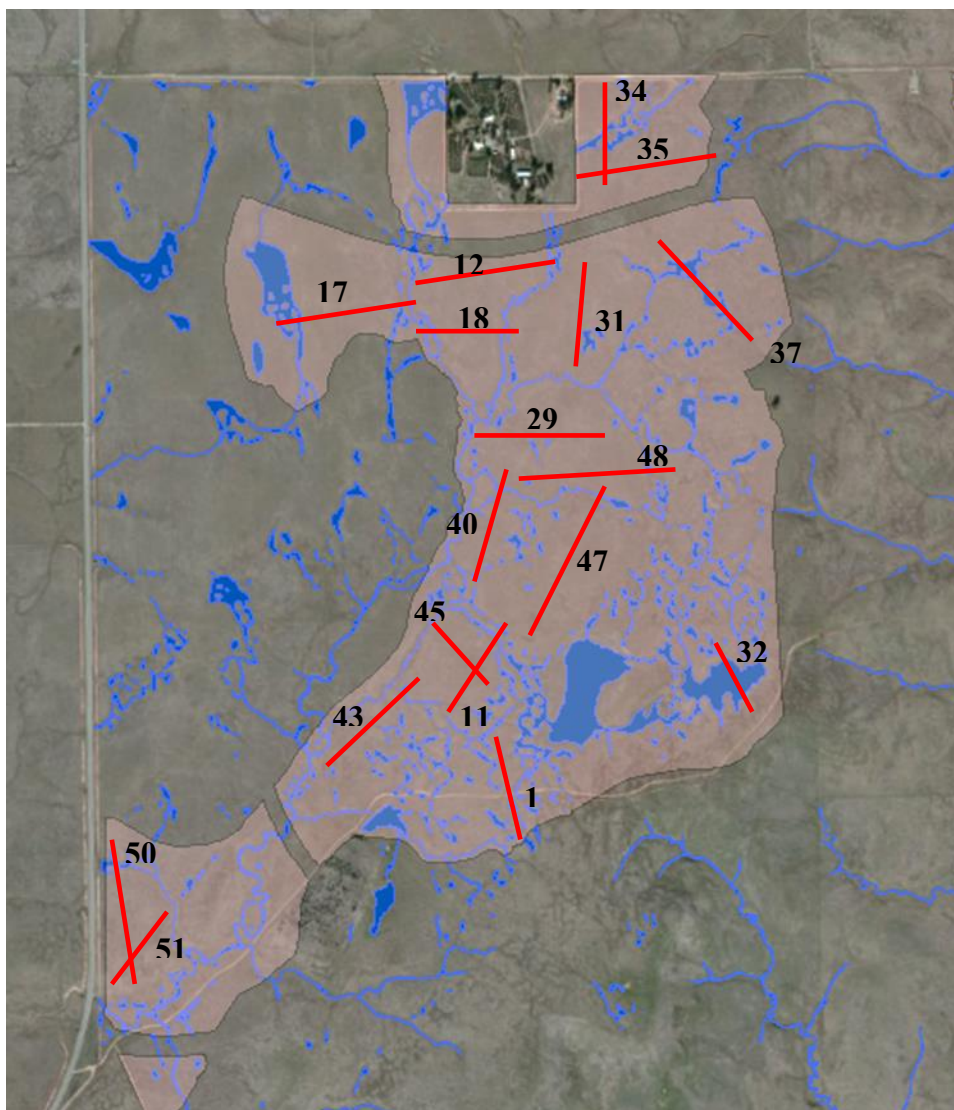
Figure 5 represents the microshed polygons that are at a scale that show the correlation of vernal pool and swale complexes and drainages with the landscape topography.

Figure 5 Cordova Hills with Existing Wetlands Bounded by Preserve Areas and Catchment Drainage Area Polygons



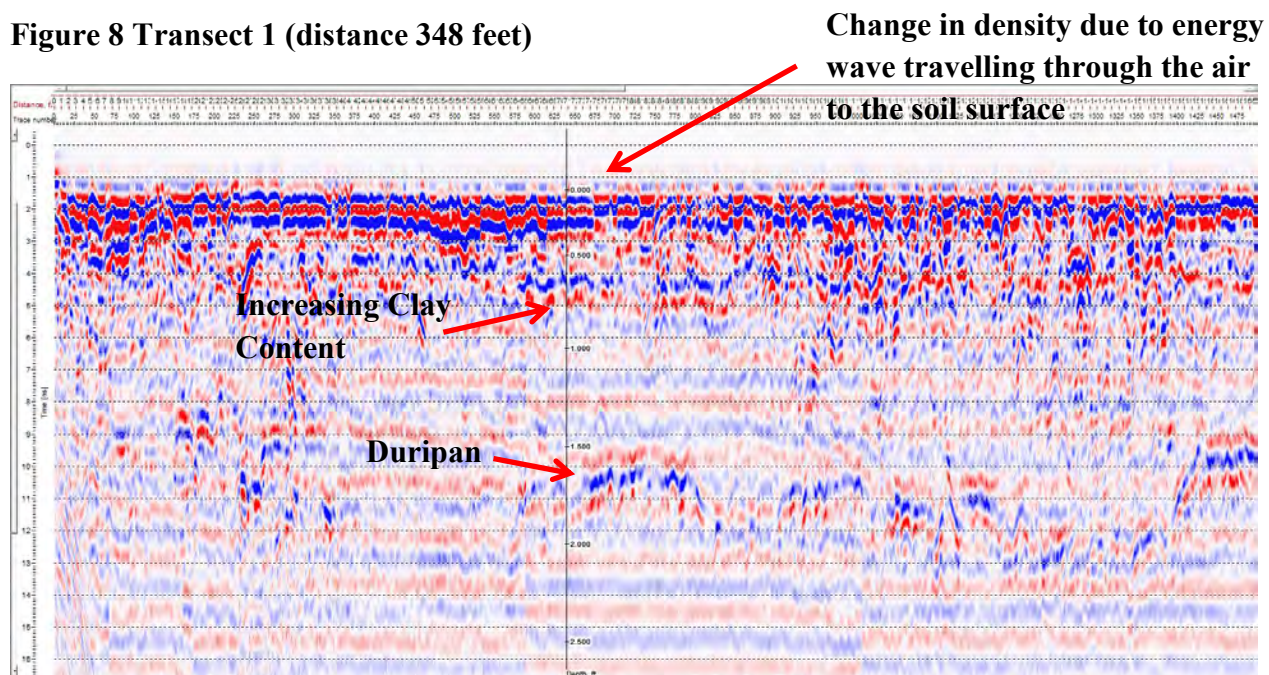
A total of 53 GPR transects were made on the site and eighteen are represented in this report (**Figure 7**). **Appendix A** shows the GPR transect profiles mapped in **Figure 7** and organized by location of potential wetland creation areas identified below.

Figure 7 Map of Transects from the GPR Survey Showing 19 Representative Areas Discussed in the Text.



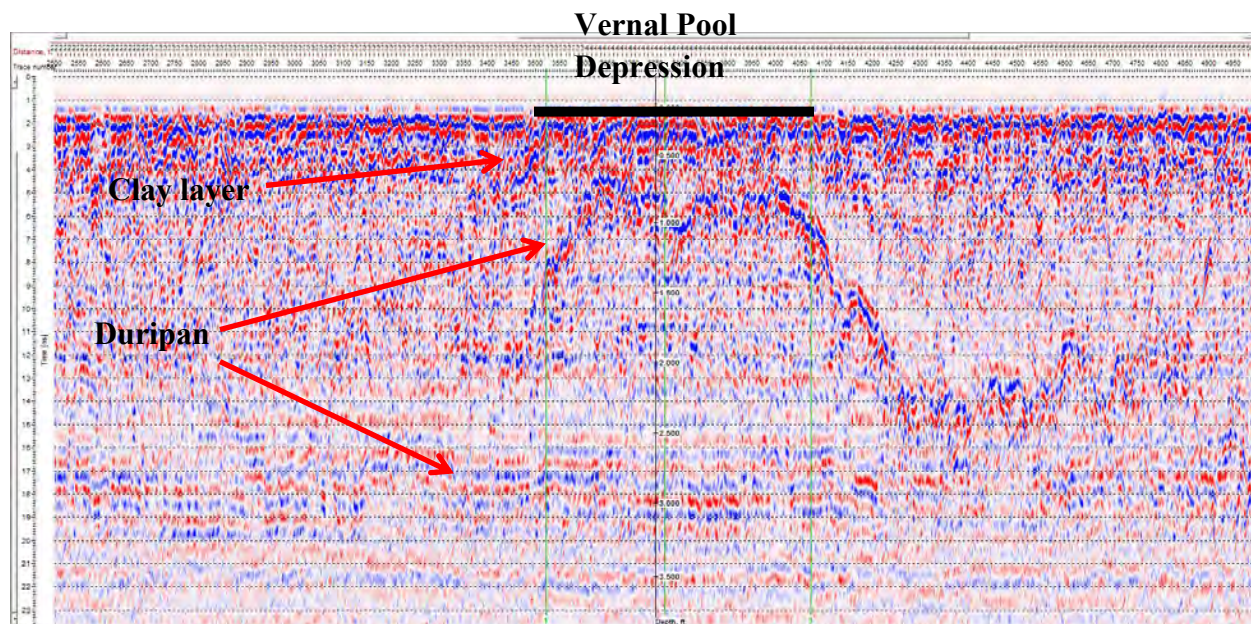
The GPR transect profiles show here are representative of the overall landscape soil profiles. The red and blue lines represent the positive and negative parts of the energy wave as it is reflected back to the GPR antenna. Changes in density of the material will result in a change in the intensity of the color of the red and blue water signatures. Natural vernal pool and swale systems were surveyed to identify the range of depth of water-restricting layers beneath a vernal pool depression as well as the depth in the surrounding uplands. **Figure 8** shows GPR transect 1 which crosses a typical part of the landscape. Within the figure a water-restricting layer called a duripan can be observed within a zone of 1.5 feet to 2 feet below the soil surface. An increasing amount of clay is also observable from the GPR wave density signatures within the upper one foot.

Figure 8 Transect 1 (distance 348 feet)



Important vernal pools were those that contained the endangered plant Sacramento Orcutt grass (*Orcuttia viscida*). **Figure 9** is GPR transect 34 that crossed a vernal pool that has Sacramento Orcutt grass. Part of the duripan is close to the soil surface within the vernal pool depression while a deeper layer of duripan is flat relative to the soil surface. Examples of other vernal pool profiles including one with Sacramento Orcutt grass (Transect 37) are in **Appendix A**. The depth to the duripan in the vernal pool GPR profiles was between one to a half a foot below the soil surface. The depth of duripan in the uplands, when present, was within two to three feet.

Figure 9 Transect 34 Local Vernal Pool with *Orcuttia viscida* (vernal pool width 61 feet)



The GPR data were very useful to identify the presence, continuity, and depth variation of the duripan and clay layers. In most of the GPR transects the duripan was present although sometimes it was difficult to observe probably due to local areas of high clay content. High clay soils maintain more water can attenuate the energy wave and reduce the signal. Some soils may have a thicker clay layer overlaying the duripan which can act as a water-restricting layer.

The GPR data are consistent with the mapped soil series from the NRCS Web Soil Survey (**Figure 10**). The two main soil series, Red Bluff-Redding Complex and Redding gravelly loam, represent over ninety two percent of the area (**Table 1**). These soil series are known to support vernal pools due to the presence of a water-restricting layer or duripan (Smith and Verrill1998).

Figure 10 NRCS Web Soil Survey Map for Cordova Hills Property.

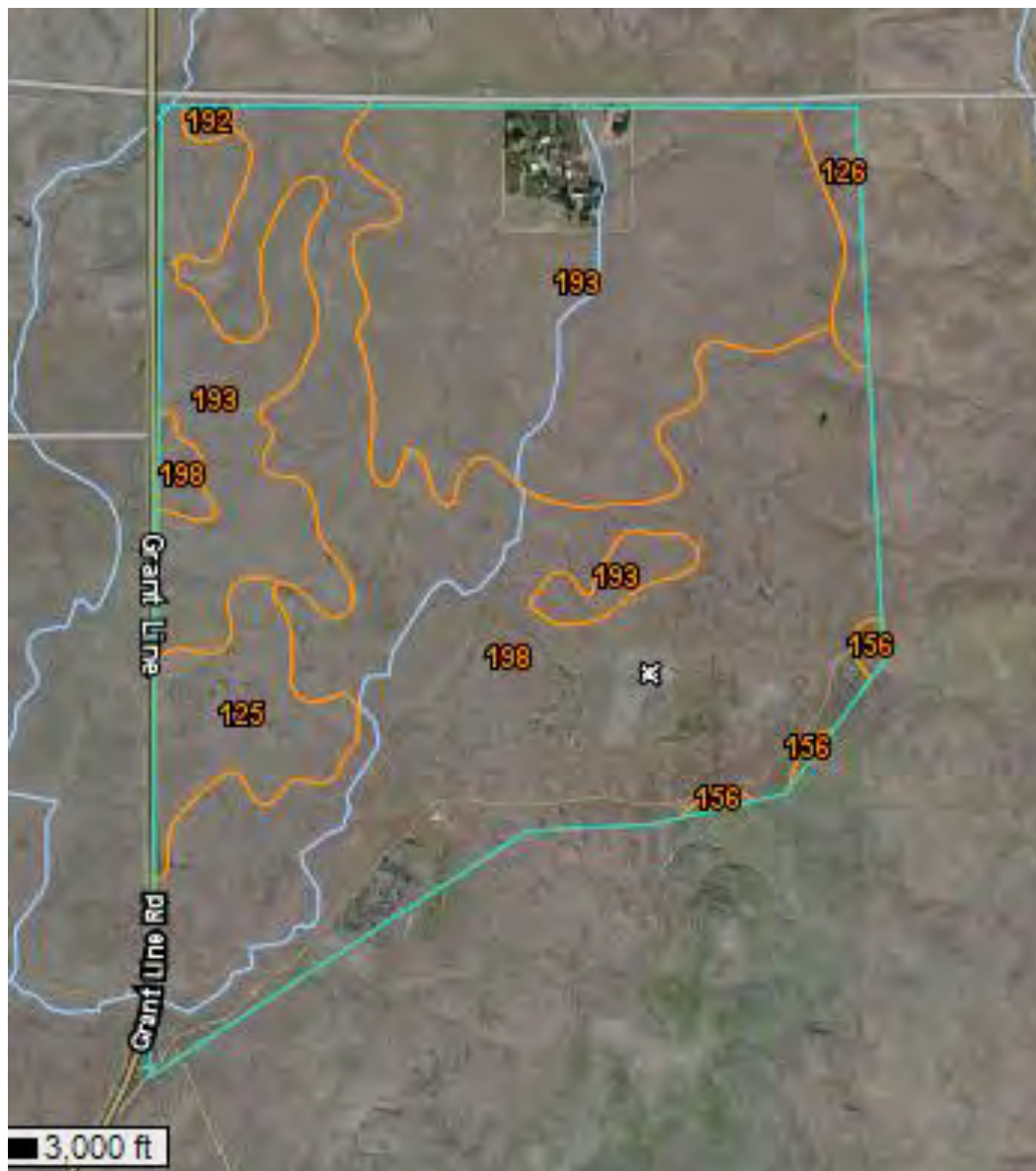


Table 1 NRCS Soil Series in Figure 10.

Soil Series in the Cordova Hills Property, Sacramento County, California

Map Unit Symbol	Map Unit Name	Acres in Area	Percent of Area
125	Corning complex, 0 to 8 percent slopes	37.6	5.4%
126	Corning-Redding complex, 8 to 30 percent slopes	11.0	1.6%
156	Hadselville-Pentz complex, 2 to 30 percent slopes	3.7	0.5%
192	Red Bluff loam, 2 to 5 percent slopes	2.0	0.3%
193	Red Bluff-Redding complex, 0 to 5 percent slopes	278.2	39.8%
198	Redding gravelly loam, 0 to 8 percent slopes	366.2	52.4%
	Totals for Area of Interest	698.7	100.0%

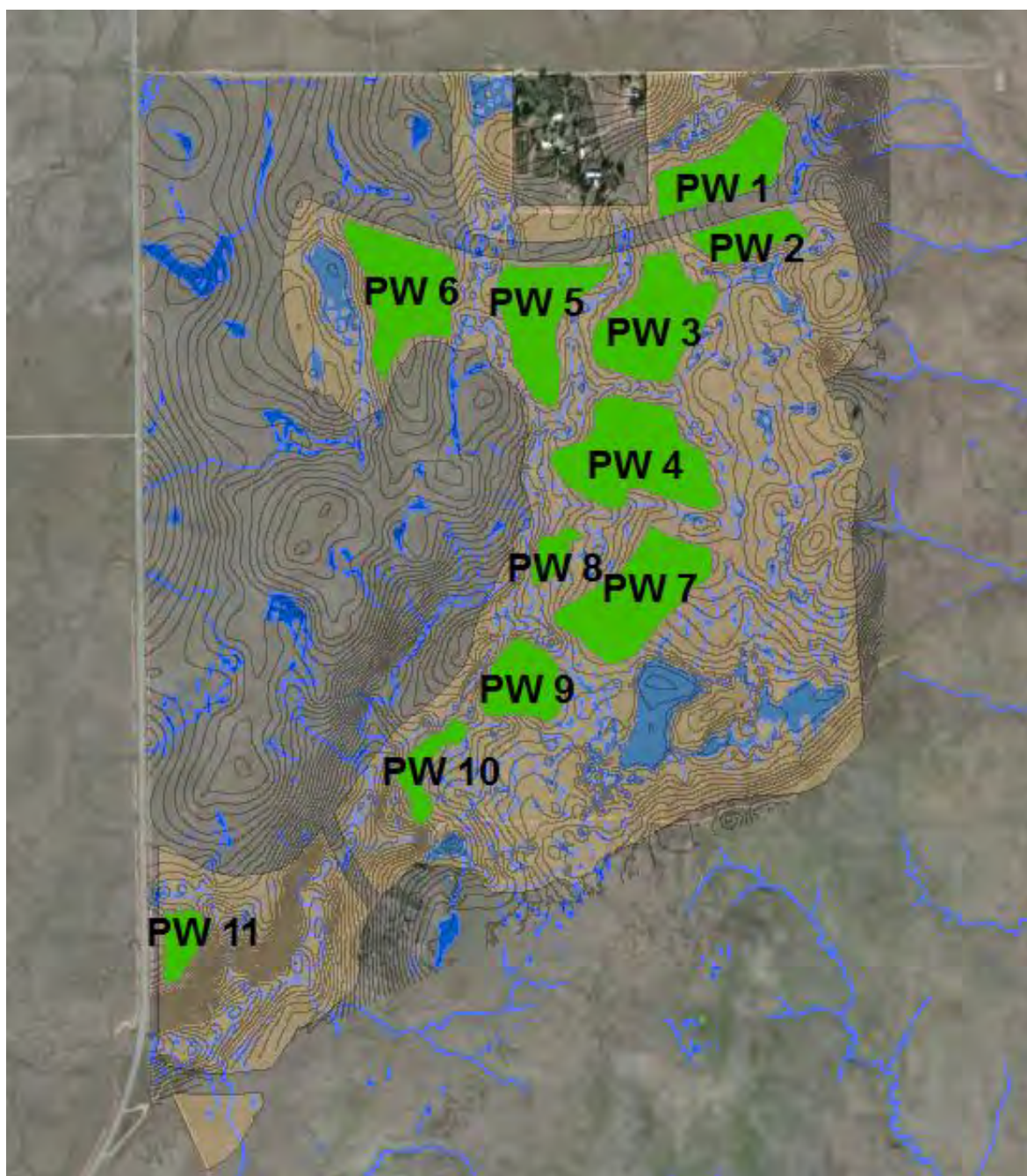
Discussion

The data analysis for the project site determined there were some areas, with further study, could be used for creating additional vernal pool and swales wetlands. Eleven areas were identified have a low elevation gradient with relatively large areas of upland and the soils have a duripan or clay water-restricting layer within the upper two and half feet (**Figure 11**). **Table 2** identifies each Potential Wetland Area, the approximate acres, reference GPR transect (**Appendix A**), potential and constraints and potential acres of creation based on a 5% and 10% of area scenarios. These scenarios are given to estimate a maximum level (10%) potential because it is the higher end of natural vernal pool densities and half that value. The ultimate potential is based on the soil type, depth to water-restricting layer and presence of existing vernal pool acres. All the areas have constraints because there are existing vernal pools in the general area. Some areas have higher potential constraints due to the presence of endangered species.

Table 2 Potential Wetland Areas for Construction

Potential Wetland Area	GPR Transect(s)	Potential & Constraints	Potential Acres (5% of Area)	Potential Acres (10% of Area)
Potential Wetland Area 1 (12 acres)	34 & 35	High catchment area has Sacramento Orcutt grass	0.6	1.2
Potential Wetland Area 2 (7 acres)	37	High catchment area has Sacramento Orcutt grass	0.35	0.7
Potential Wetland Area 3 (18 acres)	31	High/existing vernal pools	0.9	1.8
Potential Wetland Area 4 (22 acres)	29 & 48	High/existing vernal pools	1.1	2.2
Potential Wetland Area 5 (15 acres)	12 & 18	High/existing vernal pools	0.75	1.5
Potential Wetland Area 6 (17 acres)	17	High/existing vernal pools	0.85	1.7
Potential Wetland Area 7 (19 acres)	47	High/existing vernal pools	0.95	1.9
Potential Wetland Area 8 (3 acres)	40	High/existing vernal pools	0.15	0.3
Potential Wetland Area 9 (9 acres)	11 & 45	High/existing vernal pools	0.45	0.9
Potential Wetland Area 10 (5 acres)	43	High/existing vernal pools	0.25	0.5
Potential Wetland Area 11 (4 acres)	50 & 51	Medium small catchment area	0.2	0.4
Total Acres 131			6.55	13.1

Figure 11 Areas of Potential Wetland Creation



Next Steps

Most of the Potential Wetland Areas have a high feasibility of their suitability as vernal pool creation sites. Areas near vernal pools with Sacramento Orcutt grass, while have high suitability, will need very precise measurements and evaluation to ensure that creating another vernal pool would not have a direct or indirect impact to the hydrology of those vernal pools. This is fundamentally also true for other natural vernal pools. The Sacramento Orcutt grass pools have some measurable differences in the soil structure and placement in the landscape to suggest they have unusual hydrology. The specific placement and number of vernal pools will need to be determined during the development of a grading plan. Additional RTK GPS would be conducted at the locations of proposed vernal pools and swales to create accurate and precise measurements for the length of swales and for the locations and areas of vernal pools. The additional RTK GPS topography would allow for the creation of a local catchment map for each vernal pool which can then be used in conjunction with rainfall data to predict water flows into the vernal pools. Some soil pits will be needed in the uplands of potential sites to calibrate the GPR profile data to identify dense soil layers as being a duripan or clay. Also, GPR transects would be added to the specific locations to ensure depths to the water-restricting layer are consistently about 1 foot below the surface of the vernal pool basin. These data could be used to create the grading plan and simplify the grading implementation and remove guess work from the field implementation and construction. Finally, for each created vernal pool a water balance will be calculated to predict the hydroperiod (inundation period) using dry, average, and wet rainfall years prior to construction. Adjustments to pool construction design such as adjusting the depth to water-restricting layers can allow for greater diversity in hydrological functioning.

References

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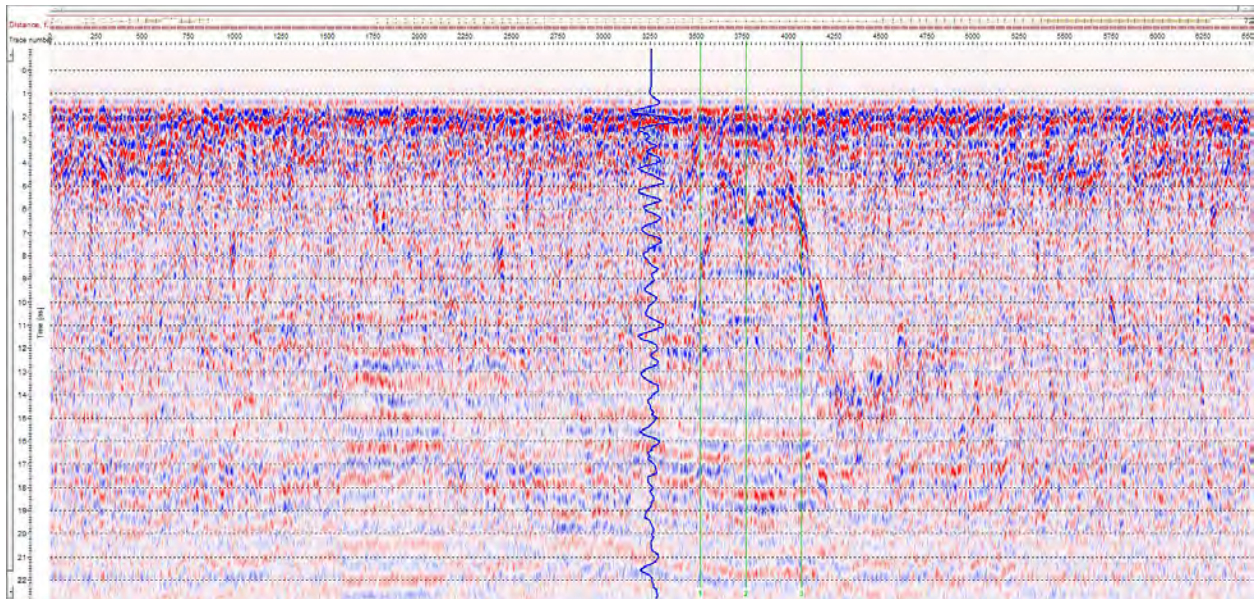
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APPENDIX A

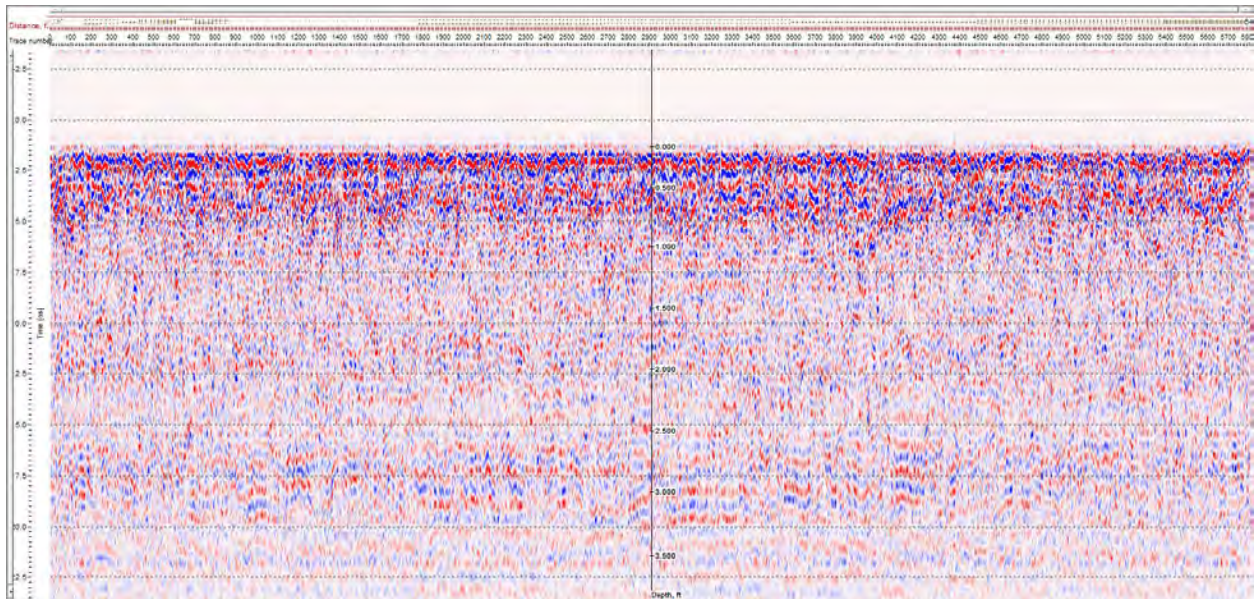
Ground-Penetrating Radar Transects Grouped by Potential Wetland Area

Potential Wetland Area 1

Transect 34 *Oruictia viscida* vernal pool transect (distance 720 feet)

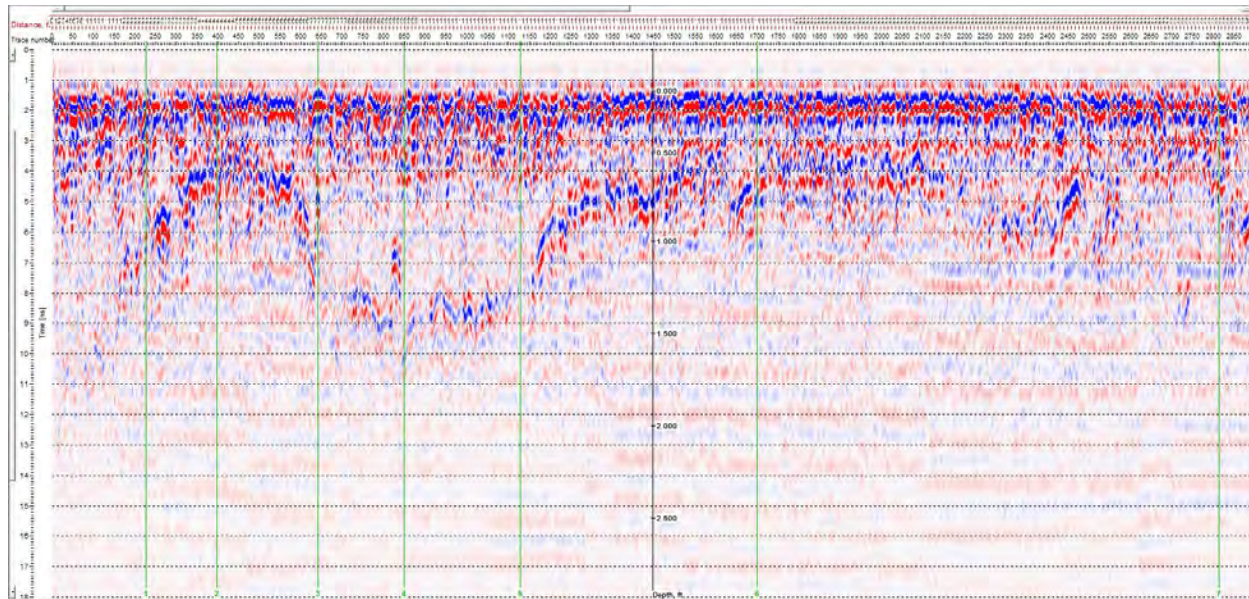


Transect 35 (distance 643 feet)

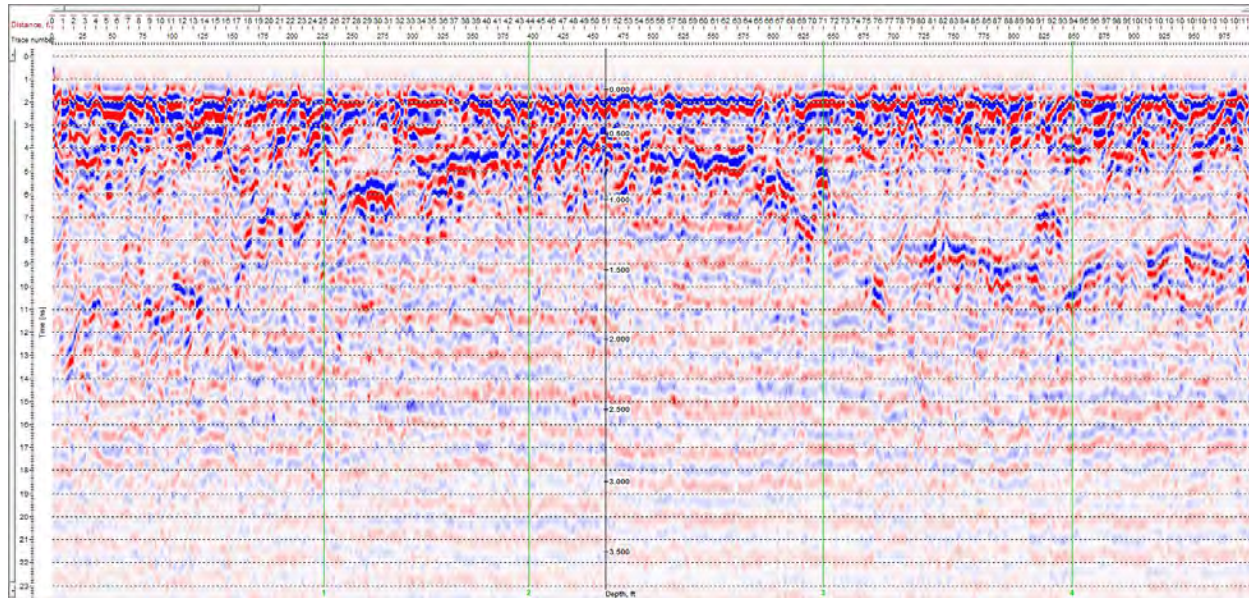


Potential Wetland Area 2

Transect 37 (distance 325 feet)

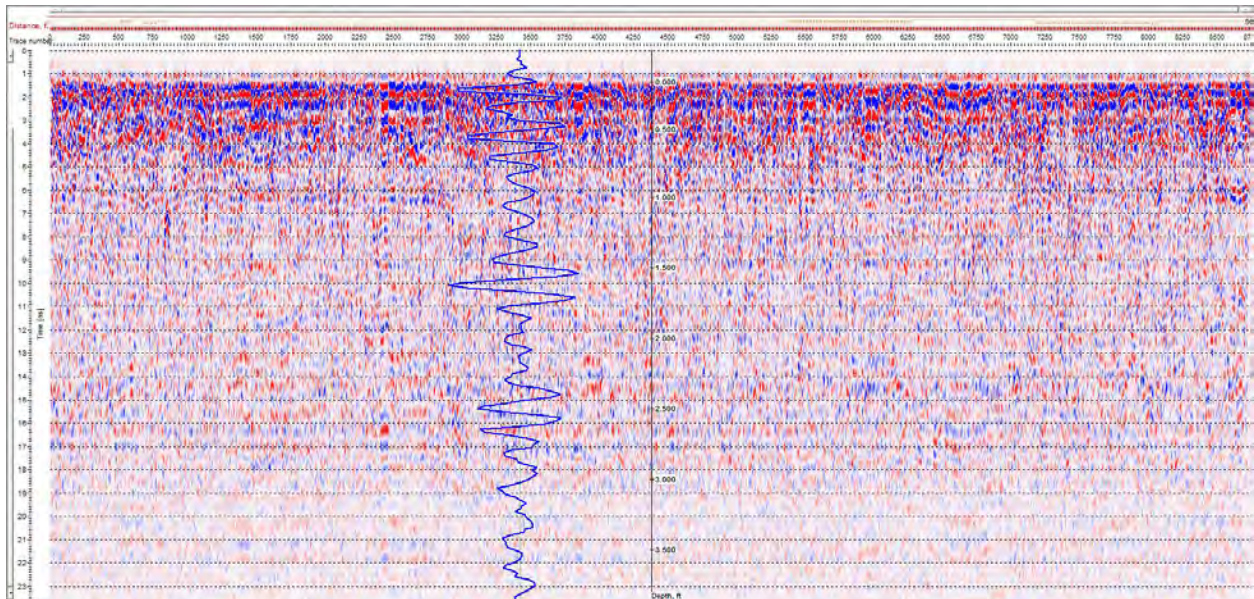


Transect 37 Vernal Pool Zone (distance 110 feet)



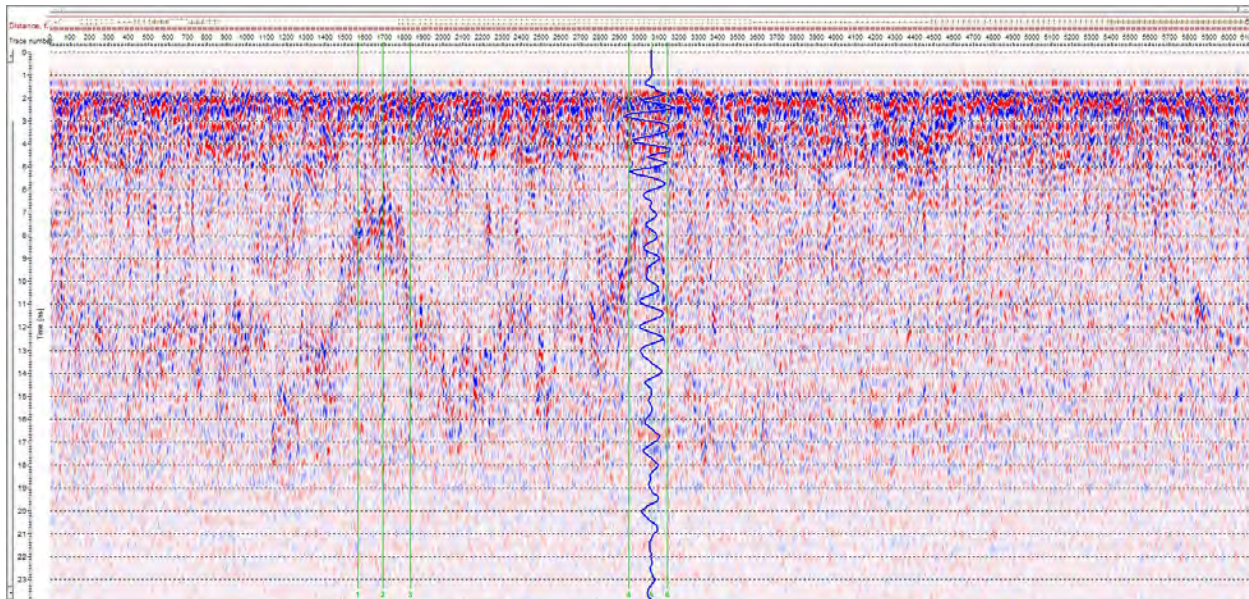
Potential Wetland Area 3

Transect 31 (distance 965 feet)

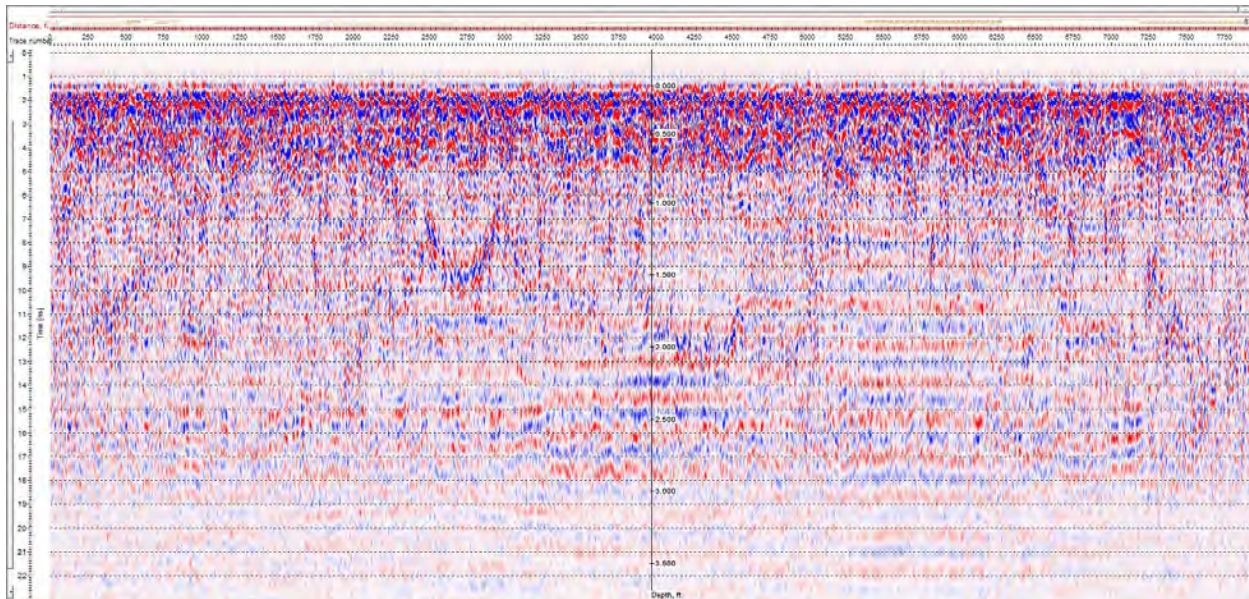


Potential Wetland Area 4

Transect 029 (Distance 676 feet)

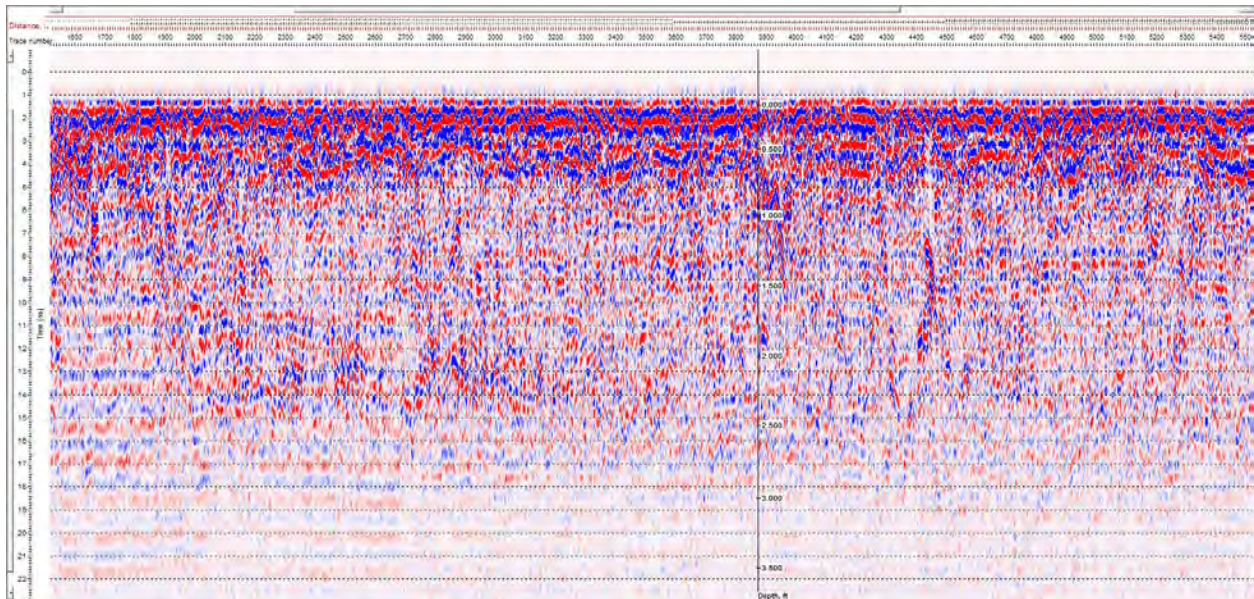


Transect 48 (distance 834 feet)

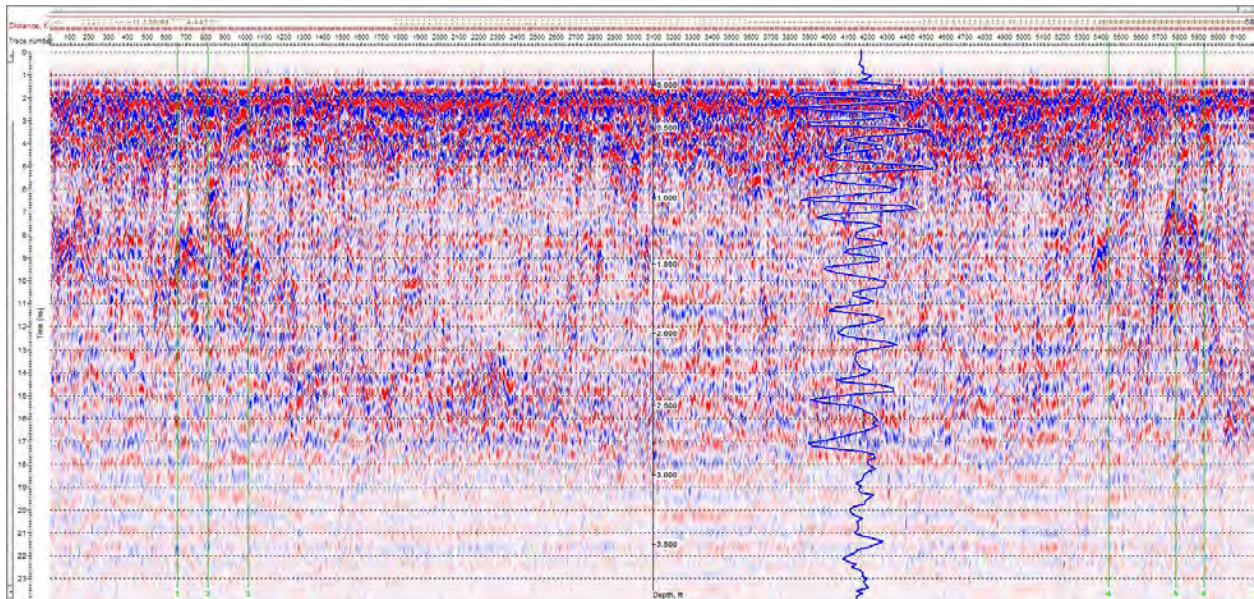


Potential Wetland Area 5

Transect 012 (distance 650 feet)

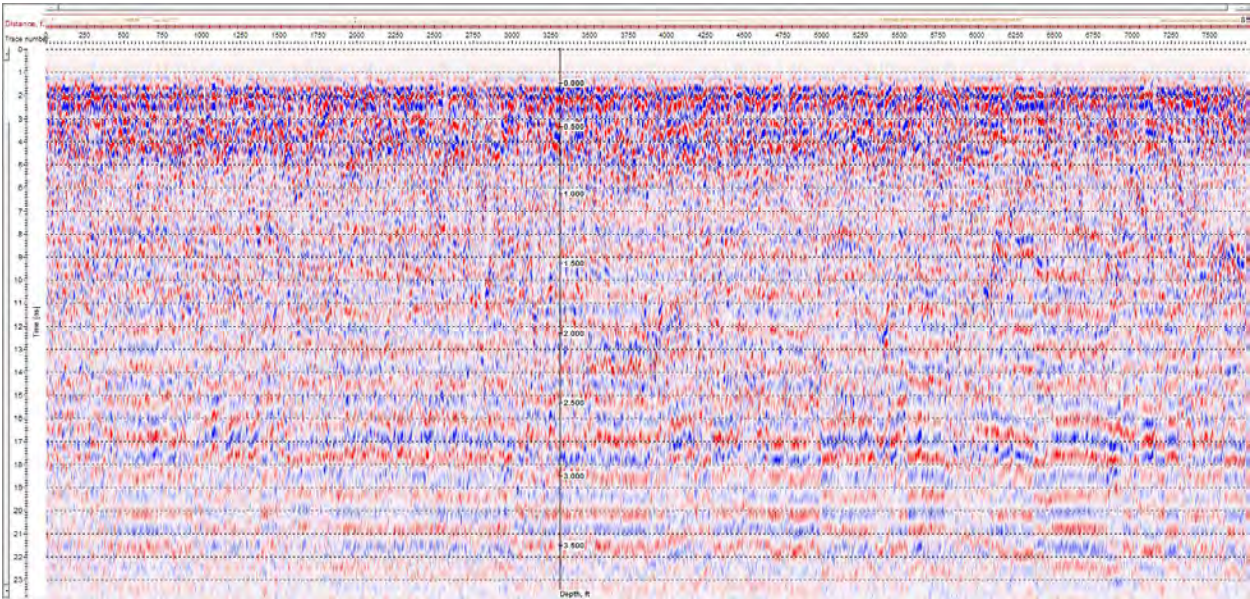


Transect 018 (distance 681 feet)



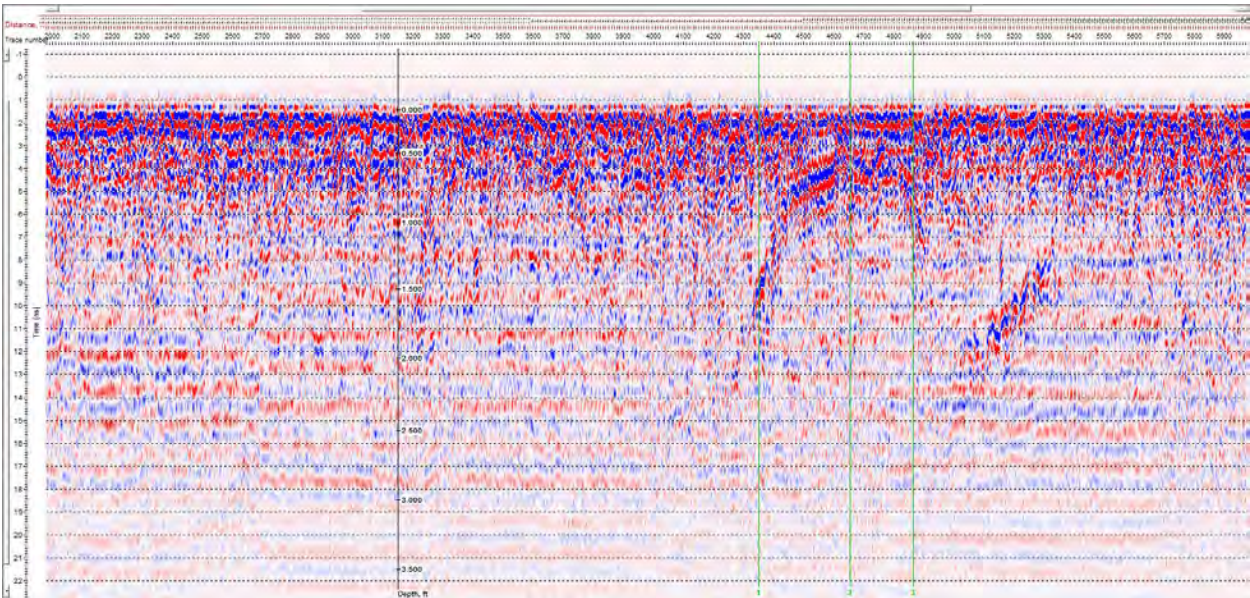
Potential Wetland Area 6

Transect 17 (distance 853 feet)



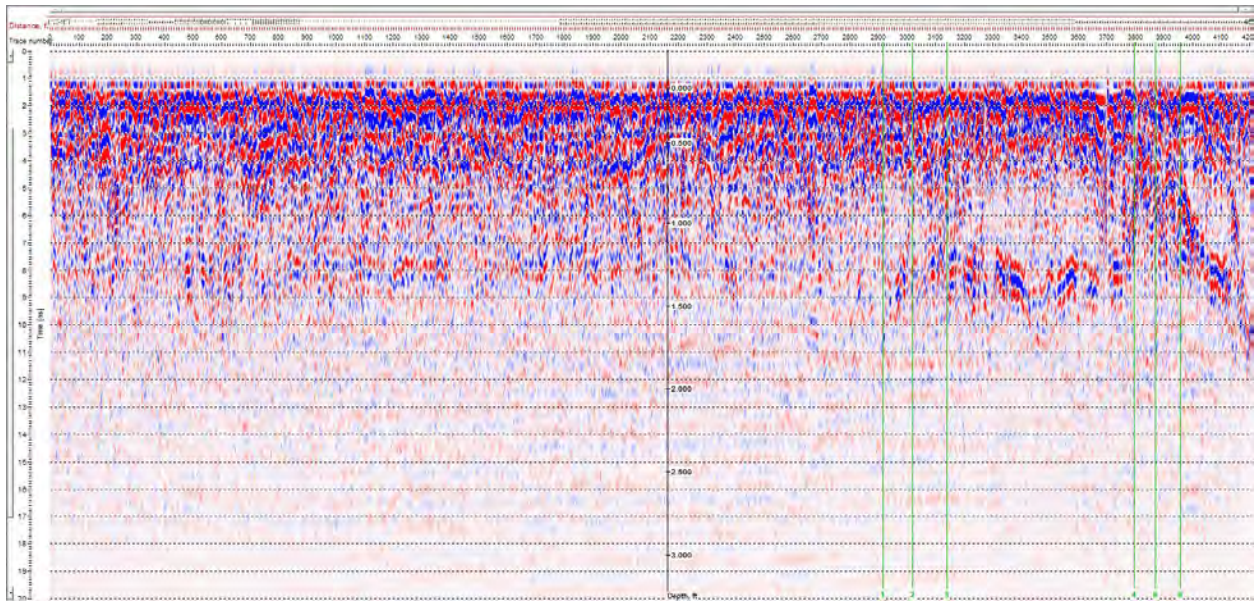
Potential Wetland Area 7

Transect 47 (distance 425 feet)



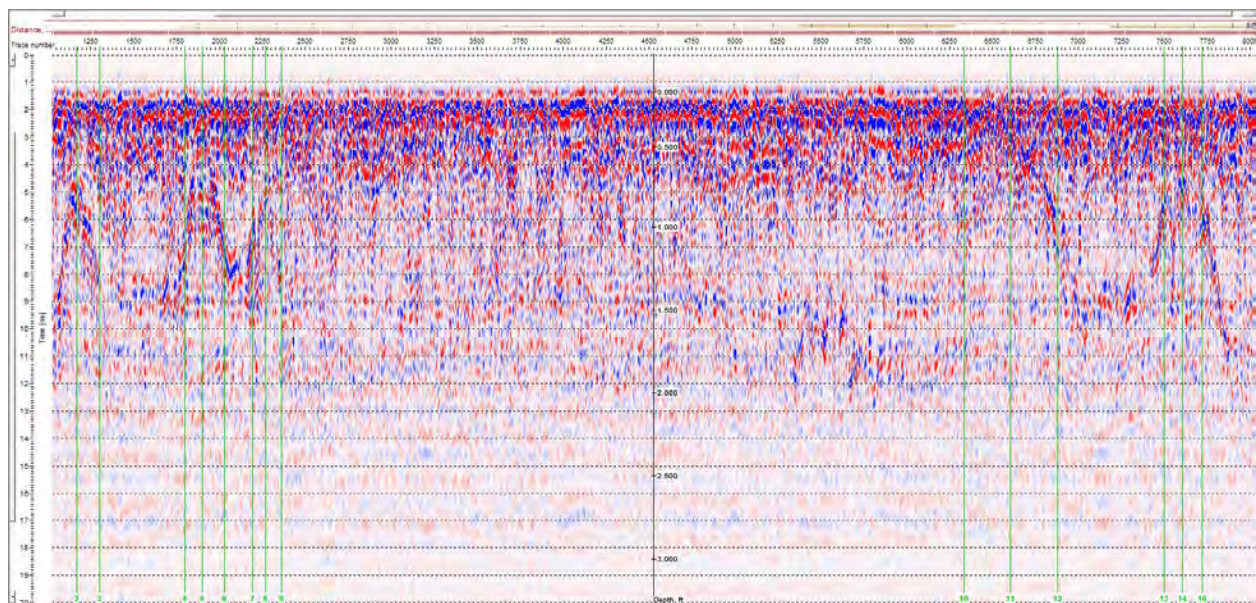
Potential Wetland Area 8

Transect 40 (distance 464 feet)

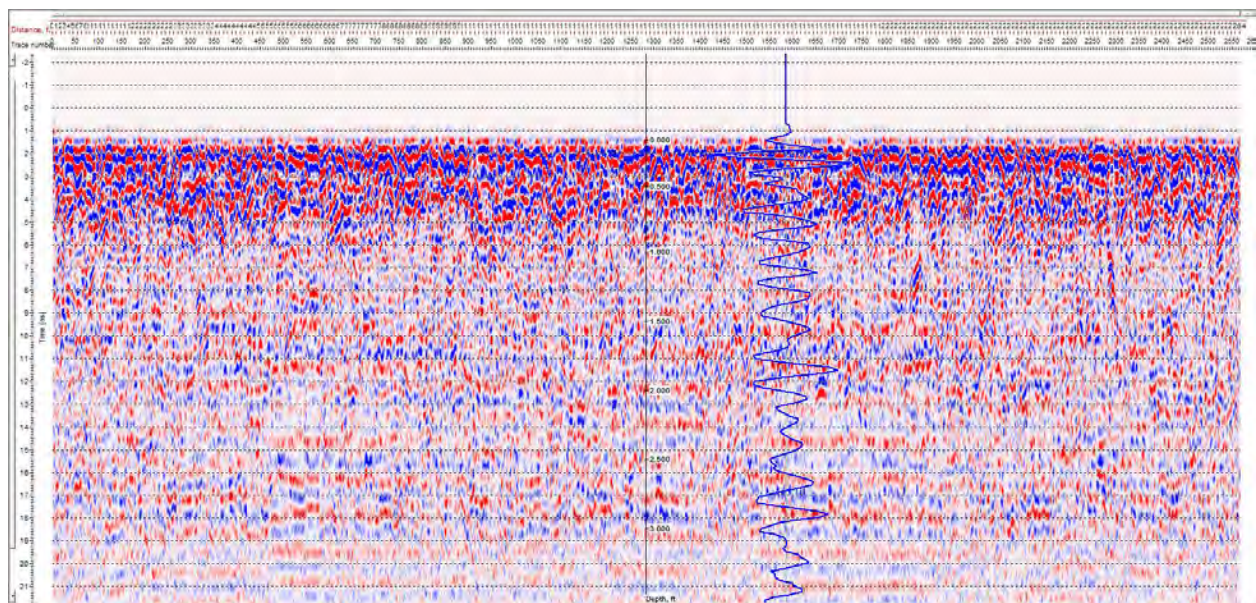


Potential Wetland Area 9

Transect 011 (distance 893 feet)

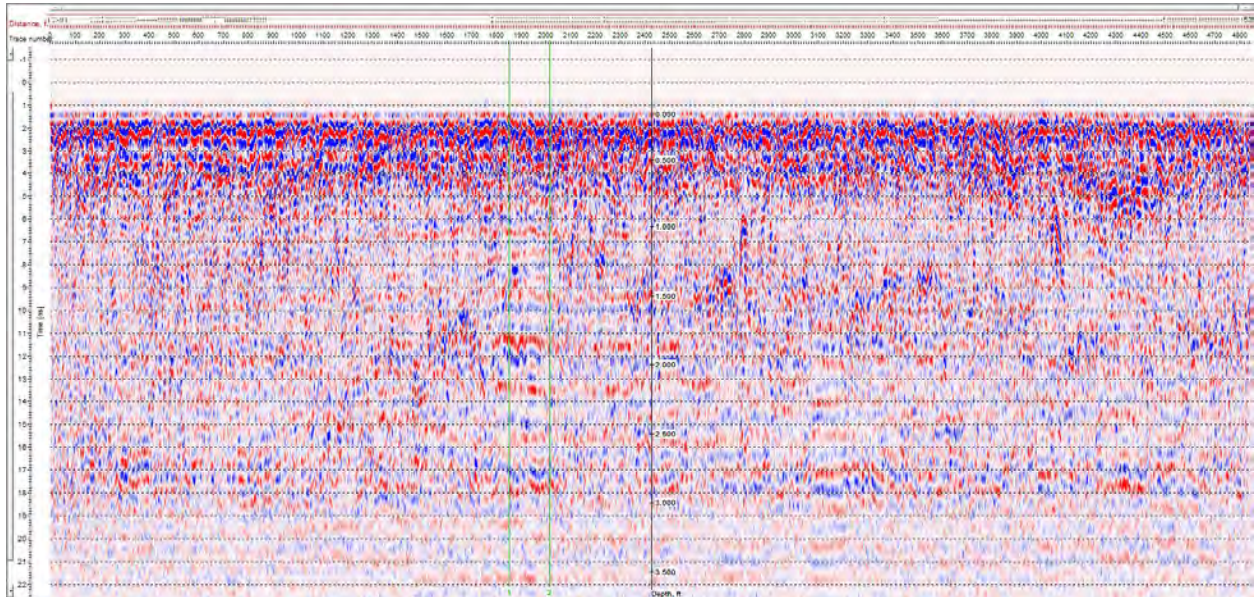


Transect 045 (distance 284 feet)



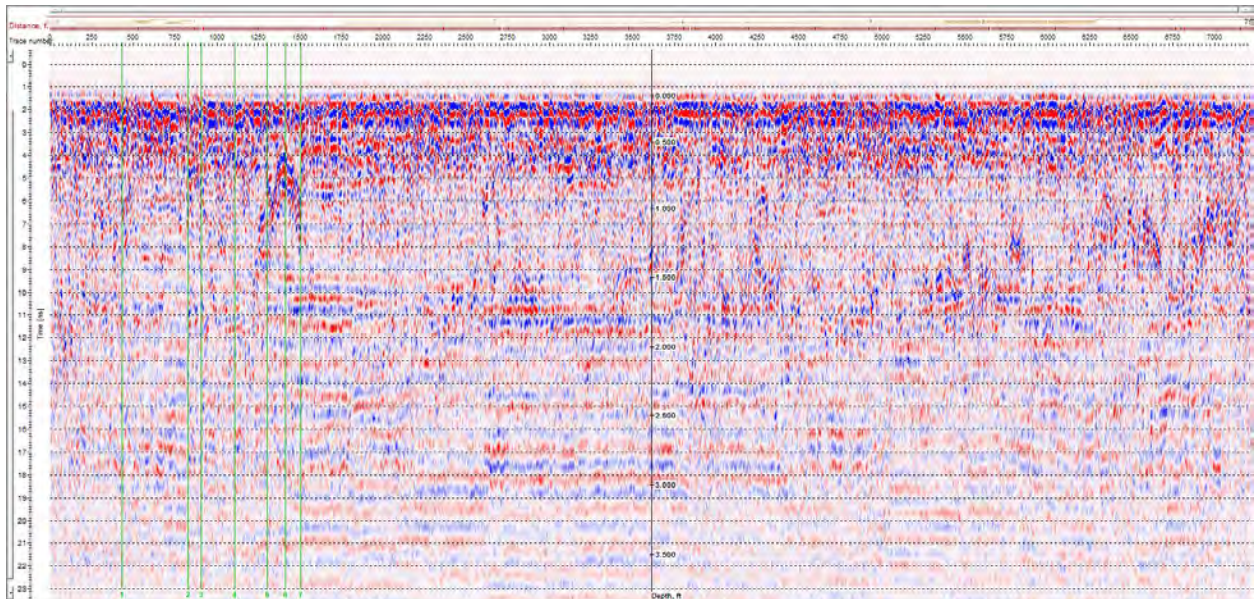
Potential Wetland Area 10

Transect 43 (distance 535 feet)

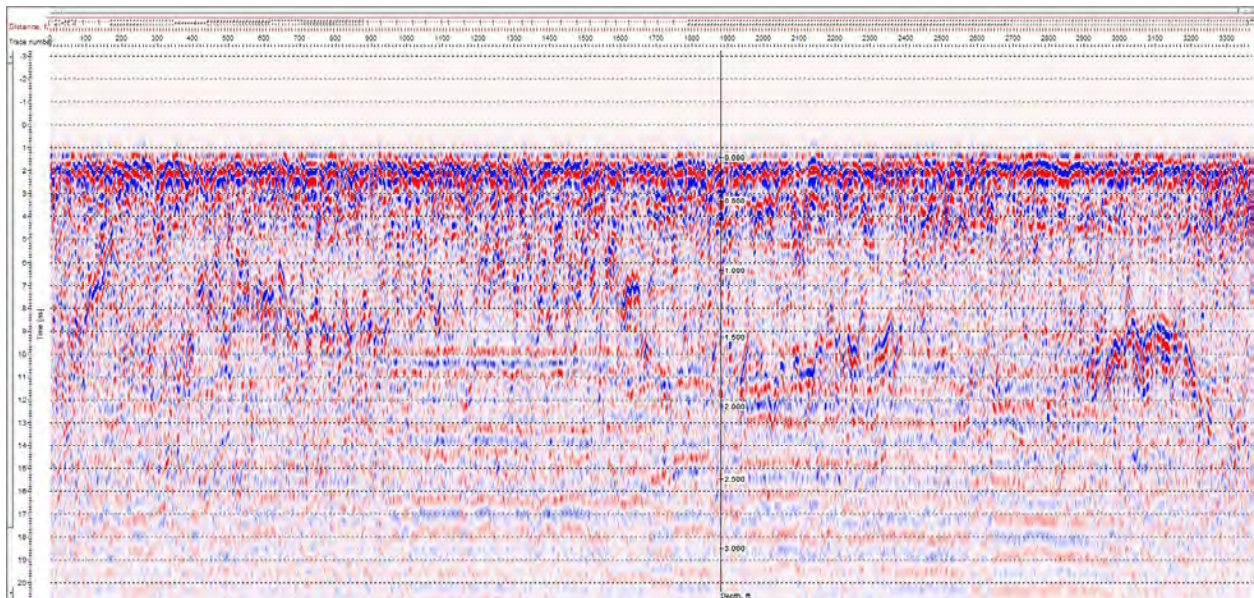


Potential Wetland Area 11

Transect 50 (distance 661 feet)



Transect 51 (distance 371 feet)



Vernal Pool Mitigation and Monitoring Plan for the Shehadeh Property

**VERNAL POOL MITIGATION AND
MONITORING PLAN FOR THE SHEHADEH
PROPERTY, SACRAMENTO COUNTY,
CALIFORNIA**

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August 4, 2014

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SECTION 1

SUMMARY

This Vernal Pool Mitigation and Monitoring Plan for the Shehadeh Property in Sacramento County, California proposes to create 29 vernal pools totaling 12.24 acres of wetlands on an approximately 160 acre site. This site is within the Mather Core area of the Southeastern Sacramento Valley of the US Fish & Wildlife Service's Vernal Pool Recovery Plan (USFWS 2013). The site currently supports 2.677 acres of vernal pools and another 5.923 acres of seasonal wetlands and swales. In addition, Laguna Creek and the intermittent Frye Creek cross the property. Key goals of the project included: 1) determine that the site is hydrologically suitable to sustain vernal pools based upon topography of the local catchments and soil profiles and 2) ensure that existing vernal pools and other wetland resources will not be negatively impacted by the addition of the created vernal pools.

The proposed project followed the US Army Corps of Engineers Wetland Mitigation and Monitoring Guidelines (2004) and first made an assessment of the site's suitability by studying the hydrology and soils. A comparison of the site with adjacent and nearby natural vernal pool landscapes provided a model used to determine the size and density of any proposed creation vernal pools. The detailed site survey to evaluate suitability included conducting global positioning system (GPS) topographic surveys to map the existing catchments of the landscape and existing wetlands. In addition, ground-penetrating radar (GPR) was used to conduct a non-invasive survey throughout the property to determine the presence, depth, and continuity of water-restricting layers needed to support vernal pool hydrology. Based on these studies it was determined that the property had extensive areas of soils including Redding, San Joaquin, and Hedge Soil Series that have water-restricting horizons including clay layers and duripans. In addition, it was found that some existing vernal pools and other wetlands adjacent to Laguna Creek did not have distinct water-restricting soil horizons but did have a shallow water table associated with the hyporheic zone of the creek which functioned as a seasonal water table for these wetlands. The topography of the site was found to have many localized catchments situated on a series of terraces that drain downslope to Laguna Creek. Existing vernal pools

were situated within specific catchments primarily on the mid to low terraces. We used the physical environmental parameters of slope and soil profile as a model in our design of creation pools. Catchments containing natural vernal pools were avoided in the design.

Placement of the proposed creation vernal pools was done using the topography and catchment location and identifying the direction of gravitational water flow. The majority of existing vernal pools were determined to be located within specific catchments. Thus, the placement of the majority of proposed creation vernal pools was done in different catchments. In cases where existing vernal pools shared a catchment, the proposed creation vernal pools were downslope of the existing pools. In three specific cases, proposed creation pools upslope of small, isolated, existing vernal pools were within a very large catchment that would supply sufficient water downslope to any wetlands at lower elevations. The depth of the proposed construction excavation for the vernal pool basin was modelled from those of existing natural vernal pools and using the depth to the clay horizon or duripan from the GPR soil profile. The vernal pool basins were designed to vary in depth to create a range of hydrological conditions as is observed in natural vernal pools. The hydrology of vernal pools is described in relation to the variable weather conditions of Sacramento, California and the potential variation from wet, average, and dry rainfall years is described. The density of created vernal pools was 9.7% which is lower than the density of natural vernal pool complexes nearby at reference sites.

A mitigation monitoring plan is included and identifies 13 created vernal pools (45%) of the 29 created pools that will be monitored. In addition, natural vernal pools onsite and on adjacent Sacramento County vernal pool preserve property will be used as reference for hydrology and vegetation parameters and performance criteria. The monitoring plan includes using objective, automated, datalogging water level pressure transducers for hourly hydrological monitoring and vegetation survey methods which allow correlation with the hydrology data. Other standard vernal pool monitoring is included.

SECTION 2

INTRODUCTION

This Mitigation and Monitoring Plan (MMP) for vernal pools and swales was developed specifically for the Shehadeh Property, Sacramento, California (**Figures 2.1**). This site is within the Mather Core area of the Southeastern Sacramento Valley (**Figure 2.3**) of the US Fish & Wildlife Service's Vernal Pool Recovery Plan (USFWS 2013) and this site is within the Laguna Creek watershed (**Figure 2.3**).

Compensatory mitigation by creating vernal pools is a relatively common practice in California (USACOE 2004, DeWeese 1998, Ferren and Hubbard 1998, Black and Zedler 1998). The biology of vernal pools in California has been studied extensively (Barbour et al. 2007, Bauder 2000, 2005, Holland and Jain 1981). However, the importance of hydrological processes of vernal pools as a function of soils, geology, and weather variables has not been emphasized until more recently (Christopherson et al. 2013, McCarten and Christman 2014, McCarten et al. 2008, 2010, O'Geen et al. 2007, Rains et al. 2008).

The USACOE Wetland Mitigation and Monitoring Guidelines (2004) specify the need for knowledge and understanding of the hydrologic and soil characteristics of a site in the planning and site design process. A prior soil study by Mr. Joel Butterworth of ICF International (2013), determined that Redding, San Joaquin, Hedge, and Fiddymont Soil Series may occur on site. Those soils are well recognized as potentially having clay or duripan horizons that function as a water restricting layer (Smith and Verrill 1998, NRCS 2014). The presence of a clay or duripan horizon will form a shallow or perched seasonal water table (Rains et al. 2006, McCarten et al. 2008). Failures related to hydrological functioning of created vernal pools have been attributed to designs that have not considered the soils or hydrology (DeWeese 1998, Christopherson et al. 2013).

2.1 Project Goals

This Vernal Pool Mitigation Plan established a series of goals in the development of the vernal pool creation on the site:

- Goal 1 – Gather sufficient field and other data on the hydrology and soils to determine the suitability of the site to support vernal pools,
- Goal 2 – Determine the physical structure of the site to map the topography and determine locations of local catchments,
- Goal 3 – Collect detailed soils data to determine the locations where clay or duripan water-restricting layers occur and accurately determine their depth below surface and continuity,
- Goal 4 – Use the hydrology and soils data to determine the placement of every vernal pool proposed for creation and provide scientific support that these pools will function similar to natural pools existing in the area,
- Goal 5 – Ensure the placement of created vernal pools will not have a negative impact directly or indirectly on the hydrology or other parameters of existing natural vernal pools and other wetlands,
- Goal 6- Show the proposed vernal pool mitigation is comparable to natural vernal pool landscapes by using adjacent and nearby sites as references for vernal pool size and density.

2.2 APPROACH AND METHODS

The USACOE Wetland Mitigation and Monitoring Guidelines (2004) identified hydrology and soils as two critical parameters important to the site assessment for suitability for wetlands mitigation. A third parameter, connectivity, is also important and discussed later. Also those Guidelines recommend a “watershed” approach to wetland design. The previous biological studies (ECORP 2013) and soil study (ICF International 2013) provided good basic information on the current conditions and biological and wetland resources of the site. Vernal pool and other seasonal wetlands require more detailed data and analyses to determine the physical parameters

of the landscape and soils to assess suitability for hydrological functioning. Vernal pools have two key physical environmental components that provide natural functioning including adequate upland water inputs within a catchment and the presence of a water-restricting soil layer. The area of the catchment and the presence and depth of a water-restricting layer determines the hydrological functioning of a vernal pool (Rains et. al 2006, McCarten, Rains, and Harter 2008). The topography of the landscape defines the potential input of water into vernal pools from the surrounding uplands.

Reference Sites

Vernal pool landscapes are unique in their structure, and individual vernal pools have hydrological functioning that is dependent on the input of water from the surrounding local catchment. Limits on the size of vernal pool basins and the density of pool basins in terms of optimal hydrological functioning can be determined from comparison of vernal pool sizes and densities in nearby landscapes. Two reference sites (**Figure 2-4**) were used to compare their vernal pool size and density with existing and proposed creation vernal pools on the Shehadeh property. Reference Site 2 (**Figure 2-5**) is particularly important because it is also adjacent to Laguna Creek and has the same soil series as the project site. These reference sites were studied by Witham et al. (2013) for their percent vernal pool cover and found to have greater than 10% vernal pool cover. The Shehadeh site covers 160 acres of which 16.198 acres are wetlands and creeks and an additional 16.3 acres are slopes greater than 3% and not suitable for vernal pools. Therefore, about 126 acres of the site have potential for vernal pool creation assuming the catchment and soils are suitable and there would be no direct or indirect impacts to existing vernal pools from the construction activities. *This information was used as guidance for determining an upper threshold of vernal pool density of approximately 10%.* Areas of existing individual natural vernal pools on the Shehadeh property are generally less than 0.1 acre with an average of 0.05 acres, with larger pool basins ranging from 0.15 up to 0.22 acres. Natural vernal pools on Reference Site 2 have larger basin areas (see **Figure 2-4**) ranging from 0.21 acres up to 1.1 acres.

METHODS

We used a Trimble Real Time Kinematic Global Positioning System (GPS) to gather surface topographic data with a spatial resolution of +/- 1 cm and elevation of +/- 2 cm. This level of precision is needed to develop topography for vernal pools and low elevation gradient terraces. Nearly 4,000 data points were collected on the site with higher density point data collection in and around existing vernal pools and other wetlands.

A Mala Geosciences ground-penetrating radar (GPR) system using an 800 MHz shielded antenna on a cart was used to on-destructively survey the soil profile at the site. The GPR sends an energy wave from the antenna and collects a reflection wave from the soil based on the density variation within the soil profile. The GPR system was programmed to collect a data sample every 2 cm and the depth of soil horizon measurement was typically set at 4 feet. Measurements combining the GPS with GPR to provide topographic adjustment to the GPR soil profiles were conducted by using simultaneous GPS topo point collection with single radar trace collection. GPR transects were conducted throughout the site (see Section 3), and all 29 of the soil pits dug and evaluated by ICF International (2013) were measured to calibrate the GPR observations with soil horizon texture. In some cases, a hand auger was used to check a GPR measurement. Over 100 GPR transects were conducted on the site varying from 25 feet long to more than 2,000 feet long.

SECTION 3

SITE EVALUATION AND SUITABILITY

This section describes the results of the field investigation and data analyses.

3.1 TOPOGRAPHY

The RTK GPS data were converted to elevation contour and digital elevation models (**Figure 3.1**). The lowest elevation was about 96.88 feet msl which was the water surface in Laguna Creek. The highest elevation measured was 125.942 feet msl on the two hilltops (one on the north side of Laguna Creek and one on the south side). Profiles of the terrain are shown in **Figure 3.2**. There are four distinct terraces on the north side of Laguna Creek. The lowest terrace is within the 100 year floodplain. The majority of vernal pools that exist on the site are within lower three terraces.

3.2 EXISTING WETLANDS

ECORP (2013) identified the existing wetland resources in a verified jurisdictional wetland delineation report. **Figure 3.3** shows the locations and extent of those wetlands overlain on a contour map and the reader should refer to the original jurisdictional wetland delineation for details as this figure groups all the wetlands together and does not differentiate natural vernal pools. The wetland report measured 2.677 acres of vernal pool wetlands and 5.923 acres of other seasonal wetlands and swales. Laguna Creek crosses the property down slope from east to west. Frye Creek is a seasonal drainage traversing from the northeast and entering Laguna Creek mid property. **Figure 3.4** shows a network of local catchments. Most of the existing wetlands are bounded by a single catchment that contributes to the water inputs to enclosed wetlands. Some vernal pool swale complexes on the South side of Laguna Creek cross catchment boundaries where both catchments are oriented downslope (**Figure 3.4**). A gravitational direction of surface flow is shown in **Figure 3.5** with vector arrows indicating the direction which water could flow from a surface point. In general, the direction of flow is toward Laguna Creek. Most of the site obtains water from direct rainfall and indirect rainfall from upland discharge downslope. Occasional flooding of vernal pools and other wetlands could occur in the lower terrace from Laguna and Frye Creeks. Most offsite irrigation drains

offsite into a canal on the east side of the property which is at an elevation equal to Laguna Creek and, therefore, would not influence the existing vernal pools. Some seasonal irrigation north of the property drains into Frye Creek but it does not appear to have any hydrological effect on the vernal pools or other seasonal wetlands and swales outside the creek based on 2014 observations. Groundwater within the hyporheic zone of Laguna Creek probably influences the hydrology of vernal pools and seasonal wetlands in the lower terrace and adjacent to the creek (see Soils Section below).

3.3 SOILS

The ICF International soil study (2013) adequately provided the general soil series as determined by 29 soil pits and should be referred to for further information. None of the soil pits were located within existing vernal pools or other wetlands due to concern over impacting them. Redding, San Joaquin, Hedge and Fiddymment Soil series were previously identified on the site as mapped by NRCS. Hedge soil series are the least developed with respect to the formation of a water-restricting layer and occur in close proximity to Laguna Creek on the lowest terrace. San Joaquin soil series are more developed and the most common series on the site occurring on the two middle terraces. It is on the San Joaquin soils that the majority of vernal pools occur. Redding soil series occurs on the higher terrace and slopes. Fiddymment is mapped by NRCS but may not occur on the site (ICF International 2013). The three main soils all typically have a loam texture in the upper horizon with a silty loam or clay loam beneath. With depth there is an increase in clay content which has a low permeability and can form a water-restricting layer when saturated. A duripan occurs in most of these soils sometimes within one foot of the surface on the upper terrace but more often at 2 to 3 feet depth below the clay horizon. The soil pits by ICF International (2013) identified varying degrees of clay content and concretion forming a clay or duripan water-restricting layer. The GPR survey of the site used the soil pit soil horizon data from that study and from many previous GPR/soil pit correlations to identify a relationship between soil texture type and density with GPR profile wave energy signatures.

The GPR survey initially conducted 67 transects on the site and **Figure 3.6** shows a

representation of some of those transects which ranged in length from about 40 feet up to 1,200 feet. Additional transects were made as part of the vernal pool design phase of the study. Further comparison was made with the soil pit information and GPR data. **Figure 3.7** shows a GPR transect from west to east covering about 330 feet and transitioning from Redding to San Joaquin Soil series. The positive/negative wave energy reflections identify the contrasting density between air to loam soil at the surface. Further below there is a second relatively higher intensity wave corresponding with higher density from increased percent clay. The lowest high intensity wave energy reflection is the duripan. Another view of the same soil profile comes from **Figure 3.8** which shows the reflection strength of the return energy wave. A blue line or “wobble” line through part of the profile confirms the change in density of the soil and the analysis process requires passing the wobble line through the profile and confirming continuity of the high density trace signals. This GPR profile passed over ICF International’s soil study pits which confirmed the depth of the beginning of the clay and duripan horizons. The GPR wave energy trace signal will not change until a new change in soil density occurs. Therefore, the clay trace signal in **Figure 3.7** between 15 and 25 cm did not show any significant new trace signal until about 0.58 meters where the duripan abruptly begins. It should be noted the ICF International soil study could only measure the depth of the clay horizon and/or duripan based on the soil pits. The GPR, as can be seen in **Figure 3.7** and other figures presented show a lot of variation in depth. **Figure 3.9** is another GPR transect on the south side of Laguna Creek through San Joaquin soil series with numerous vernal pool/swale complexes and associated uplands. Using simple soil texture names of loam, clay, and hardpan to identify differences through the soil horizon, a simple model approach is applied to the GPR energy wave data to characterize the soil profile in the transect (**Figure 3.10**).

Measuring the soil profile of existing, natural vernal pools was important to determine how the soil profile and depth to water-restricting layer compared with surrounding uplands. **Figure 3.11** shows a GPR transect crossing a natural vernal pool at the site. The hardpan begins at about 0.5 feet and continues downward in the vernal pool zone indicated. It appears the wave energy signal continues with increasing reflective strength at least to 2 feet below the surface. It is

observed that the hardpan does continue although with less reflection strength than within the pool boundary. Comparison with the ICF International soil pit data indicate that energy wave reflection trace signals in the uplands outside vernal pools are sufficiently cemented to form a good water-restricting layer. It is important to use GPR to survey all areas for creating or restoring vernal pools.

Combining GPR with RTK GPS can adjust the GPR profile to fit the elevation gradient so it is easier to understand the relationship of the soil surface and especially vernal pool depressions with respect to the GPR profile as seen in **Figure 3.12** occurring on a San Joaquin soil series.

Figure 3.13 is a topographically adjusted GPR transect through a vernal pool mapped as Hedge soil series. The Hedge soil pit data often showed a weaker hardpan presence but the GPR energy wave signal in the field and in the office was relatively strong. A hand auger was used to bore a hole to 3 ½ feet in the upland immediately adjacent to a natural vernal pool. The soil texture was sandy loam changing to sandy clay. The sandy clay potentially could form a restricting layer when dry. The auger hole found moist soil at 1.2 feet and saturated soil at 2 feet below the surface on April 29, 2014 after vernal pools throughout the site were dry to water-restricting layer in terraces at higher elevation. This indicated a shallow groundwater table and it was concluded that this is a hyporheic zone associated with Laguna Creek. The depth of soil saturation had an equal elevation as the surface water in Laguna Creek about 40 ft. south of the auger hole. Smith and Verrill (1998) identify some vernal pools as forming on soils including poorly developed xerfluents that have a shallow groundwater. It is probable that all surface soil depression wetlands and swales within the lower terrace (e.g. up to about 102 feet elevation), could experience seasonal hyporheic groundwater inputs. **Figures 3.14** and **3.15** show other GPR transects through other types of geomorphic situations including drainage and a seasonal swale, respectively.

3.4 HYDROLOGICAL PROCESS OF CASCADING VERNAL POOLS

The hydrological experience of a vernal pool in any year is the result of the physical setting as determined by the catchment or surrounding uplands that contribute water from upslope to the

pool and the depth of the clay or duripan water-restricting layer (**Figure 3-16, 3-17, and 3-18**) and the seasonal weather variables. Christopherson et al. (2013) identified that small or restricted catchments surrounding a natural or created vernal pool can result in a short hydroperiod. Therefore, vernal pools require sufficient upland water inputs to meet the seasonal requirements to saturate the soil followed by inundation within the pool basin. Vernal pools in sequence along an elevation gradient will share portions of the catchment water inputs with those pool basins higher up the slope receiving typically less water than those downslope. Those pool basins lower on the slopes obtain water through subsurface connectivity from those pools upslope (**Figures 3-17 and 3-18**). The only water losses from pools upslope are from evapotranspiration. The most important parameter of cascading vernal pools is the area of the upland catchment will provide sufficient water inputs with direct rainfall to result in soil saturation and basin inundation. **Figure 3-18** shows the cross-section of a cascading vernal pool system with the water inputs and outputs. Natural vernal pools on the Shehadeh property were measured to have an upland catchment greater than twice the area of the vernal pool. Therefore, a vernal pool basin would represent about 30% or less of the total area of the local catchment.

Weather variables and regional climate are the other parameters needed to fully evaluate the existing and potential hydrology of vernal pools. California's Mediterranean climate is characteristically highly variable from year to year. **Figure 3.19** shows annual rainfall values from 1975 to 2013 for Sacramento, California. This time span includes some of the lowest rainfall values recorded, such as about 6 inches during the 1976-1977 drought, as well as some of the highest values recorded, including 37 inches during El Niño in 1982-1983 and again with 33 inches in 1997-1998. Locally, in Fair Oaks, California, during the 1997-1998 El Niño event rainfall was measured at 38.32 inches (Department of Water Resources, CIMIS Station). **Figure 3.20** shows monthly rainfall values and it is important to keep in mind that the seasonal timing of the rainfall can have a significant effect on the ultimate hydrology of a vernal pool.

It was also found that relatively deep soils (> 20 inches) overlaying a clay or duripan can require too much of the direct rain water and catchment water to saturate the soil before the perched

water table appears in the pool depression. In contrast, a very shallow (< 5 inches) soil horizon over the water-restricting layer will result in the soil drying out too quickly and vernal pool plants will fail to complete their reproductive cycle. These two parameters combined with the annual weather variables of rainfall and evapotranspiration (ET) determine the hydroperiod of each vernal pool. **Figure 3.21** gives the relationship between weather variables of rainfall and ET and the resulting hydrology for two years associated with one vernal pool at Mather Field, Rancho Cordova, CA. Given that the area of a catchment and the depth to clay or duripan are constants over our short time scales, then differences in rainfall and ET play a significant role. **Figure 3.22** shows how the climate water balance of rainfall minus ET can affect the hydroperiod of vernal pools. Every vernal pool has a water balance, which is determined given the soil and catchment input plus the weather variables for any year (McCarten et al. 2009). Measuring annual hydrology through monitoring will confirm a result that can be predicted based on this vernal pool water balance model (see **Figure 3-18**).

SECTION 4

VERNAL POOL CREATION PLAN

4.1 PROPOSED VERNAL POOLS AND EXISTING WETLAND RESOURCES

Using the data gathered and analyzed as described in the previous section, we identified 29 sites for potentially creating vernal pools (**Figures 4.1 and 4.2**). **Table 4.1** lists each of the numbered pools and provides the acreage for each pool and a total value of 12.24 acres.

The average area of the created vernal pools is 0.422 acres. In addition, **Table 4-1** lists the catchment area of upland and direct water input as well as water input sources including direct rainfall (P), groundwater inputs from hyporheic zone (GW), and upland input from the catchment (Up). Below we describe how the data collected were used to identify the location and size of proposed vernal pools. We used the following features and parameters in our decision-making:

- Avoid impacting the hydrology of existing vernal pools and other wetland resources,
- Low slope Topography and sufficient catchment area for upland water inputs,
- Soils having a water-restricting layer and/or groundwater source,
- Hydrologic potential based on source of water inputs,

Figure 4.3 shows the proposed created vernal pools within the mapped existing jurisdictional wetlands identified by ECORP (2013).

Table 4.1 Proposed Creation Vernal Pools and Acreage, Catchment Area, and Water Inputs from direct precipitation (P), groundwater for pools near Laguna and Frye creeks, and downslope discharge from uplands within the catchment (Up).

Pool Number	Acres	Catchment Area	Water inputs
1	0.32	0.76	P + GW + Up
2	0.23	3.62	P + Up
3	0.52	1.4	P + GW + Up
4	0.42	1.3	P + GW + Up
5	0.65	1.38	P + GW + Up
6	0.46	2.9	P + Up
7	0.41	1.56	P + Up
8	0.44	2.48	P + Up
9	0.36	3.0	P + Up
10	0.31	1.35	P + Up
11	0.35	2.25	P + Up
12	0.18	0.72	P + GW + Up
13	0.65	2.57	P + Up
14	0.62	1.91	P + Up
15	0.36	3.76	P + Up
16	0.36	2.63	P + GW + Up
17	0.33	2.33	P + GW + Up
18	0.69	2.67	P + GW + Up
19	0.47	4.57	P + Up
20	0.52	3.76	P + Up
21	0.40	1.33	P + GW + Up
22	0.57	3.05	P + Up
23	0.15	0.71	P + GW + Up
24	0.44	6.14	P + Up
25	0.38	4.52	P + Up
26	0.55	2.49	P + Up
27	0.70	5.95	P + Up
28	0.13	2.28	P + Up
29	0.27	1.24	P + Up
Total	12.24	74.43	

4.2 TOPOGRAPHY AND CATCHMENT LOCATIONS

Figure 4.3 shows the position and areal extent of each proposed creation vernal pool with respect to the contour map of the site. The proposed creation vernal pools are distributed throughout the site. **Figure 4.4** shows the position and areal extent of each proposed creation vernal pool and existing wetlands overlain on the local catchments. The existing vernal pools are primarily clustered within catchments that are separated from proposed creation vernal pools. **Figure 4.5** shows the proposed creation vernal pools and existing vernal pools and wetlands overlain on a vector surface flow map. This map gives the direction of surface flow based on down slope direction indicated by the vector arrows. This figure shows the surface topography slope which parallels the subsurface water-restricting layer (see below) indicating how water discharge from the uplands through the landscape enters the vernal pools and wetlands and then discharges toward Laguna Creek. These two figures are significant because they show natural vernal pools occupy separate catchments from proposed creation vernal pools in most cases. The density of 12.24 acres of proposed creation vernal pools within the 126 acre potential area would be 9.71% which is below the 10% threshold identified based on the reference sites. In the cases where created vernal pools (examples include pools # 2, 20, and 29) are up slope and within the same a discharge catchment as a natural vernal pool. These have large contributing upland catchments (i.e., vernal pool 2 catchment of 3.62 acres, vernal pool 20 catchment is 3.76 acres, and vernal pool 29 catchment is 1.24 acres). In percent area terms, the vernal pool represents 6%, 13%, and 22% of the catchments respectively. These are relatively large upland catchment areas that will provide more than sufficient additional water. Further, the proposed upland vernal pools form a cascading process and discharge downslope so that they do not remove water directly or indirectly from any downslope natural pools other than a small amount of evapotranspiration.

4.3 SOIL AND WATER-RESTRICTING LAYERS

The suitability of a site for creating a vernal pool also requires the local soils have a water-restricting layer. After identifying potential vernal pool creation sites using the topographic and

catchment analysis, GPR data was used to determine if the locations had a water-restricting layer, the type of water-restricting layer (clay, duripan, or groundwater table), and the depth required for excavation to provide sufficient soil depth for a rooting zone yet not be too deep to require many inches of water to meet saturation prior to water inundation within the surface depression. All the proposed creation vernal pools had at least one GPR transect. **Figure 4.6** shows representative GPR transects associated with proposed creation vernal pools that are shown as figures in this section. The following figures show the GPR profile with the soil horizons of the clay and hardpan depths and these are paired with a second copy of the GPR profile that show the approximate placement of the specific proposed creation pools. **Figures 4.7(A & B), 4.8(A & B), 4.9(A & B), 4.10(A & B), 4.11(A & B), and 4.12 (A & B)**, show the GPR soil profiles and cross-sections of proposed creation vernal pools 3, 4, 8, 9, 11, 6, 13, 19, 25, and 28, respectively. These examples show how the vernal pool basin was designed so excavation of surface soil creates a pool basin with the lowest depth at the zone where there is a soil horizon transition to a higher clay content causing a reduction in water infiltration. There is typically 1 foot of clay horizon +/- 4 inches above the hardpan creating adequate depth for plant roots while requiring 6 inches +/- 2 inches of water to saturate the soil. The bottom of the pool basins vary in depth to create a range of hydrological conditions within each pool which is common in natural vernal pools and leads to higher plant species diversity. This variation in depth also allows for deeper parts of the pool basin to continue to have longer hydroperiods even during dry years so that native vernal pool plant species are sustained. Further, having deeper parts of the pools permits a broader range of hydrology that potentially can benefit vernal pool macroinvertebrates and rare vernal pool plants which are typically found in deeper pools.

4.4 HYDROLOGY SOURCE AND POTENTIAL

The estimated hydrology of the proposed creation vernal pools was calculated based on estimated direct rainfall (P) and additional rainfall that has infiltrated into the soil in the uplands within a pool catchment area. As stated above, natural vernal pools have at least twice the area of the vernal pool basin as uplands indirectly contribute water to the pools. The proposed creation vernal pools all have at least twice the upland area relative to the pool basin (**Table 4-1**). Most of

the proposed creation pools have relatively large catchments and upland water contributions. In ten cases, the pools are near Laguna and Frye Creeks and they will experience some groundwater contribution when the water levels in the creeks are seasonally high. All the proposed vernal pools have sufficient upland catchment area to sustain natural seasonal hydrology equal to the conditions experienced by the natural vernal pools onsite.

CONCLUDING STATEMENTS

This proposed vernal pool creation mitigation plan identified the Shehadeh Property as having suitable hydrological and soil characteristics as recommended by the USACOE Wetland Mitigation and Monitoring Guidelines (2004). We determined the suitability based on the following factors:

- Occurrence of natural vernal pools and other seasonal wetlands,
- Presence of soils, including Redding, San Joaquin, and Hedge soil series, that are well known to have water-restricting layers that are required for the development of a seasonal perched water table and the observation that wetlands adjacent to Laguna Creek have a shallow water table that substitutes for a water-restricting layer,
- Data were collected on the topography of the site to develop detailed contour maps, vector flow maps, and local catchment boundaries,
- GPR was used to conduct non-invasive surveys of the soil profiles throughout the site and found extensive areas having clay, duripan, and shallow water table conditions that would function as water-restricting layers,
- Weather variables and history was evaluated with respect to hydrological processes of vernal pools from the region, and
- Existing wetland resources were evaluated and reference vernal pool landscapes were used to set thresholds for the area and density of vernal pools proposed for creation.

The siting and size of the proposed creation vernal pools was based on the following features:

- Local catchments were identified where vernal pool creation could occur without negatively impacting existing vernal pool or other wetland resources,
- Contour maps, and vector flow gradient maps identified that all but three vernal pools are hydrologically isolated or downslope from existing vernal pools. The three pools (2, 20 and 29) upslope from existing non-vernal pool wetlands have extensive upland catchments that could support the addition of flow-through vernal pools,
- GPR soil profiles were used to show the presence and depth of water-restricting layers and the proposed creation vernal pool cross-section were overlain on the GPR profiles to

show the depth needed for excavation for the bottom of the vernal pool to occur just above or on the initial clay layer and providing about 1 foot of depth to the duripan which is an average soil depth for natural vernal pools. The pool basins were designed to vary in their depth to create a broader hydrological gradient within each pool.

- The proposed creation vernal pools range in size from 0.23 acres up to 0.7 acres with an average area of 0.422 acres. This is within the range of existing natural vernal pools on the Shehadeh property and the adjacent reference sites.
- The proposed creation vernal pools are distributed throughout the site and within their local catchment and with sufficient uplands to provide additional water input. The overall vernal pool density (including wetlands identified as “seasonal wetlands and swales”) for the Shehadeh property would be 9.71% based on 129 acres of area less than 3% slopes and less the area of all existing wetlands and creeks.

Avoiding Existing Wetlands

A key goal was to ensure that existing vernal pools would not be directly or indirectly negatively impacted from the proposed vernal pool creation and mitigation. Most of the proposed creation vernal pools are greater than 300 feet from existing vernal pools. Those pools that are less than 300 feet from vernal pools are within separate catchments or are downslope from existing natural vernal pools such as pool 10 (see **Figure 4-3, 4-4 and 4-5**). The pools that are upslope from seasonal wetlands and swales have sufficient upland catchment areas and the upslope water input would discharge out of the proposed creation vernal pools downslope to the other wetlands. The proposed creation pools upslope would not change the rate of flow into seasonal pools and swales downslope in the specific cases identified.

SECTION 5

MONITORING PLAN

The annual monitoring plan will conduct seasonal field measurements and data collection for use in evaluating performance of the created vernal pools when compared with specific performance criteria. The following list identifies the field parameters that will be measured:

- Hydrology – hourly data will be collected using water level pressure transducers placed in slotted PVC pipes in a bore hole augured to the depth of the hardpan (**Figure 5.1**). The data will be used to develop a hydrograph and determine the number of hours or days of surface water inundation and soil saturation in the plant rooting zone. The bore hole will be placed at the lowest point of the vernal pool basin. The performance standard will be created pools will have days of inundation no more than 20% below the average inundation period of all references vernal pools during average and above average rainfall years and within the range of the lowest inundation period of reference pools during below average rainfall years.
- Vegetation Sampling –. Absolute and relative cover of vernal pool endemic species* in constructed pools should be within or exceed the range exhibited by the reference pools. The number of vernal pool endemics in constructed pools should be within or exceed the range of the number of vernal pool endemics exhibited by the reference pools. The number and cover of non-native species in constructed pools should be within or below the range of the number and cover of non-native species exhibited by the reference pools.
- Plant Species Identification and Cover – A list of species will be developed for each pool. Plant species with cover values of 5% or higher observed in the sample plots will be recorded in increments of 5%. The measurements include absolute and relative by measuring the percent bare ground for the sample plot relative to vegetative cover and then measuring percent individual species cover relative to vegetative cover,
- Plant species in the sample plots will be identified as native or non-native and for their USFWS Wetland Indicator Status (OBL, FACW, FAC, FACU, UPL).
- Special-status macroinvertebrates will have wet season sampling of the subset of

monitoring pools during three times each year during average and above average rainfall years. No specific performance criteria are identified at this time for listed macroinvertebrates.

Monitoring Schedule

The monitoring will be conducted over a period of 10 years. Thirteen proposed creation vernal pools will be monitored out of the 29 created (**Figure 5-2**). Hydrology will be monitored annually for the 10 year period using the automated pressure transducing water level dataloggers. Vegetation monitoring will be conducted 6 of the 10 years, with 2 years monitored during average rainfall years, 2 years monitored during below average (more than 4 inches below average), and 2 monitoring events during higher than average rainfall years (more than 3 inches above average). Special-status macroinvertebrates will have wet season sampling of the subset of monitoring pools during three times each year during average and above average rainfall years.

Performance Success Criteria

Table 5.1 Performance Success Criteria

Vernal Pool Variable	Data Compared to Measure Success	Success Criterion
Surface Water Hydrology	Days of Surface Water Inundation	Within the range of the reference vernal pools (see description in text)
Plant Species Cover	Native vs Non-native species	Within 25% of the reference pools (see description in text)
Plant Species	OBL, FACW, FAC	Within 20% of the reference pools (see description in text)

SECTION 6

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Figures

Section 2

Figure 2.1 Regional Location Map of Shehadeh Property, Sacramento County, California

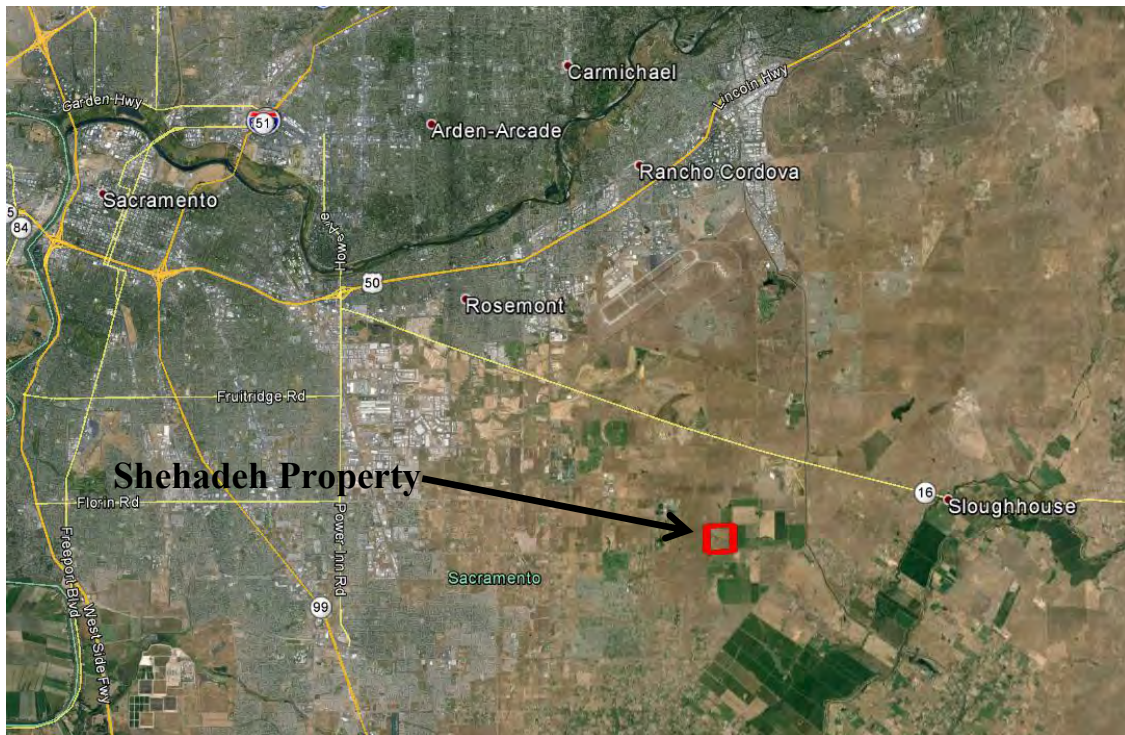


Figure 2.2 Regional Location Map of Shehadeh Property, Sacramento County, California

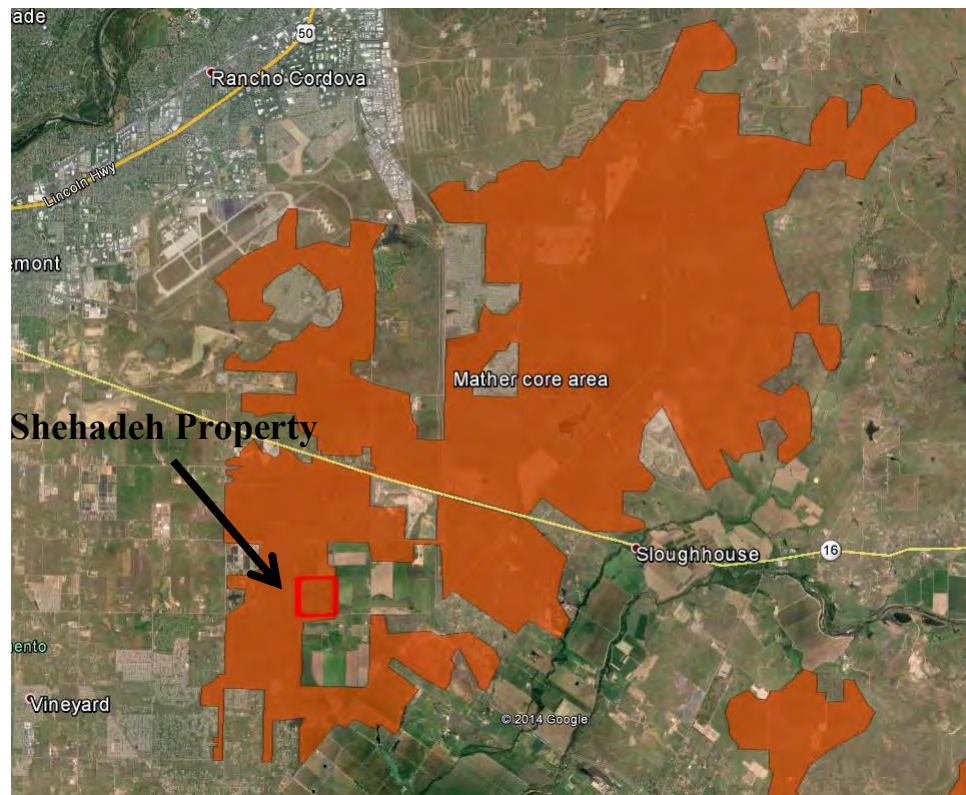


Figure 2.3 Showing Shehadeh Property Boundary and Landscape Setting in a Natural Vernal Pool Landscape Associated with Laguna Creek and Irrigated Farmland.

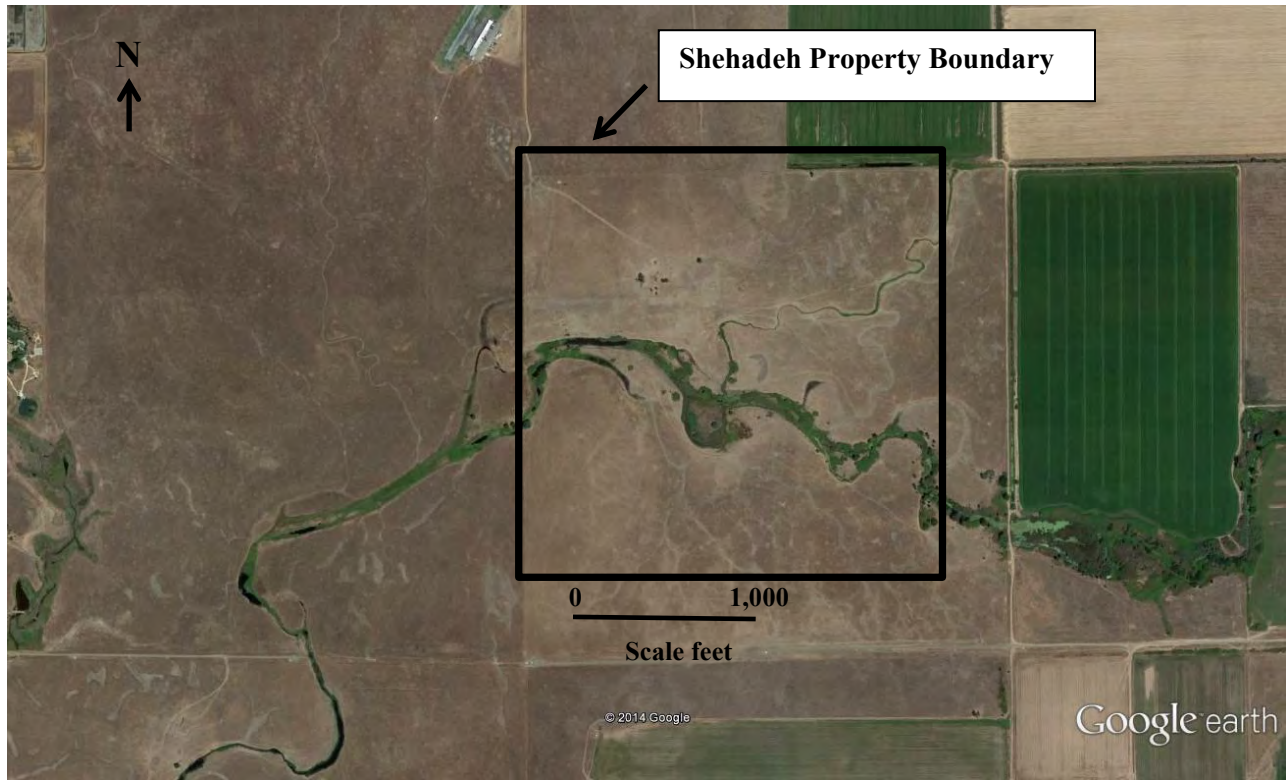


Figure 2.4 Reference Vernal Pool Landscapes Sites

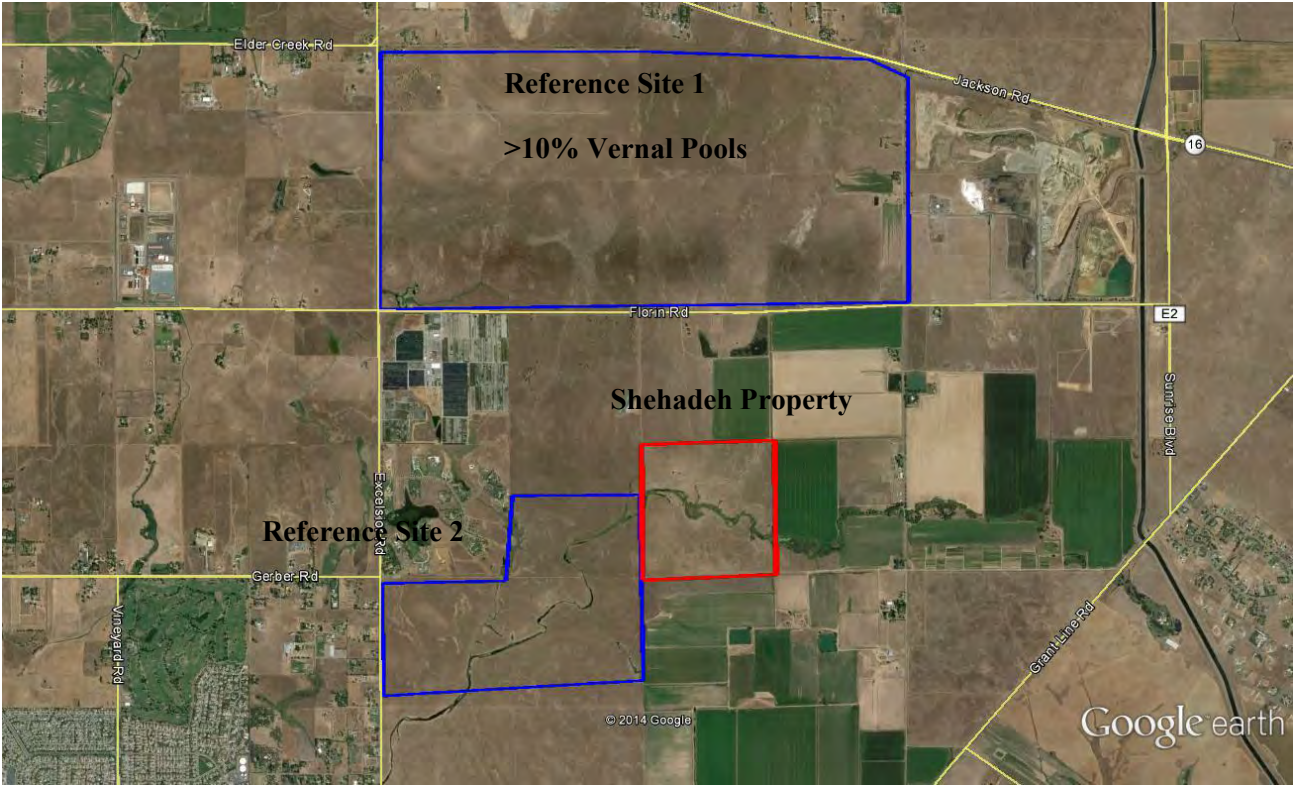
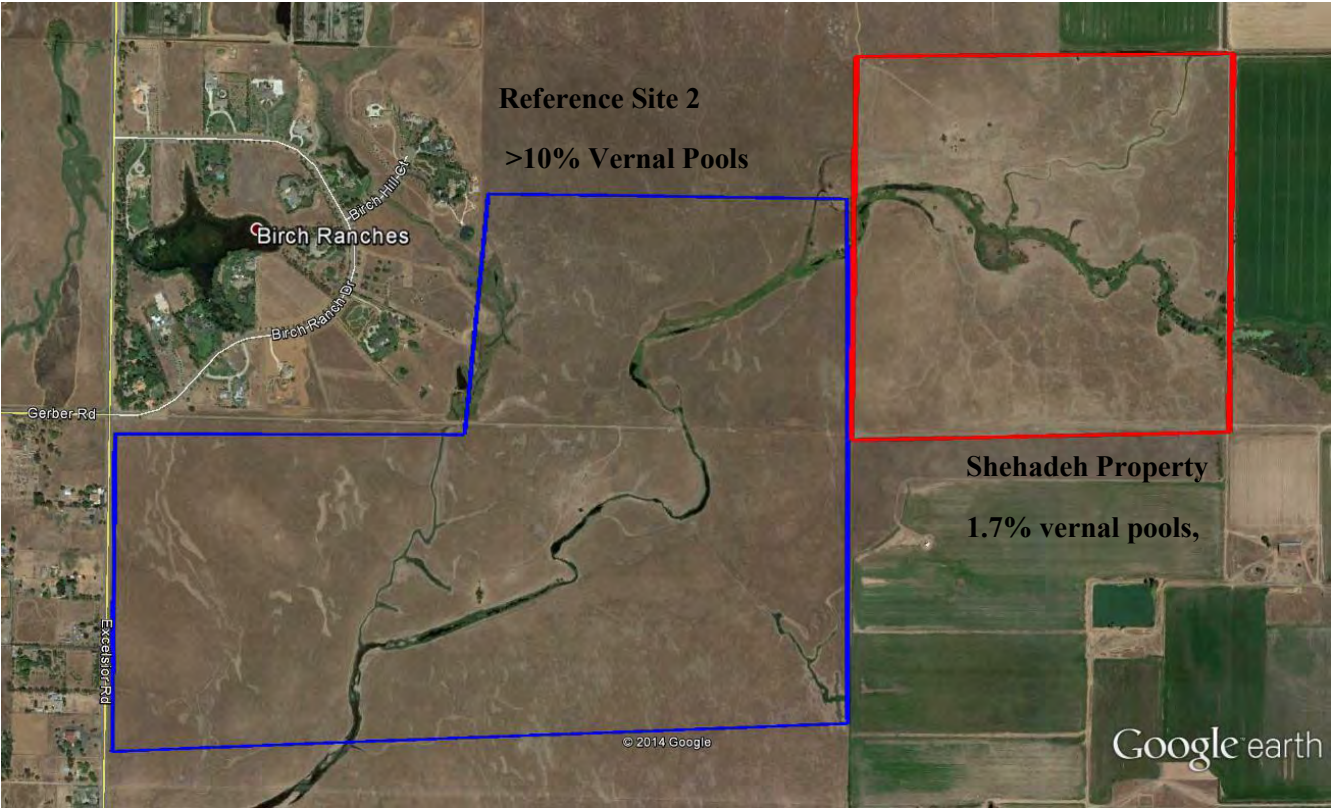


Figure 2.5 Reference Vernal Pool Landscape Site 2 Adjacent to Laguna Creek



Section 3

Figures 3.1 Elevation Contour Map of Shehadeh Property

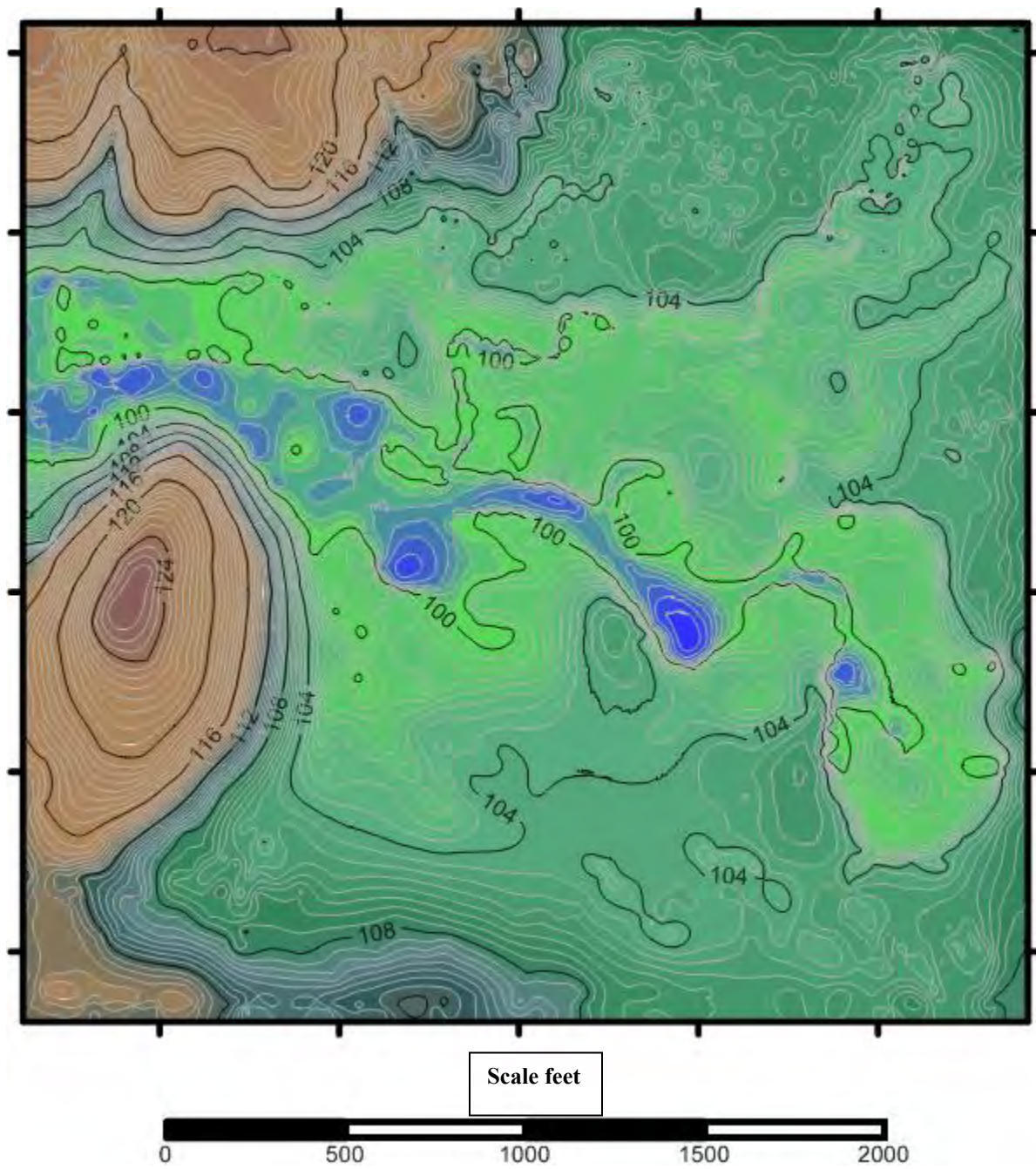
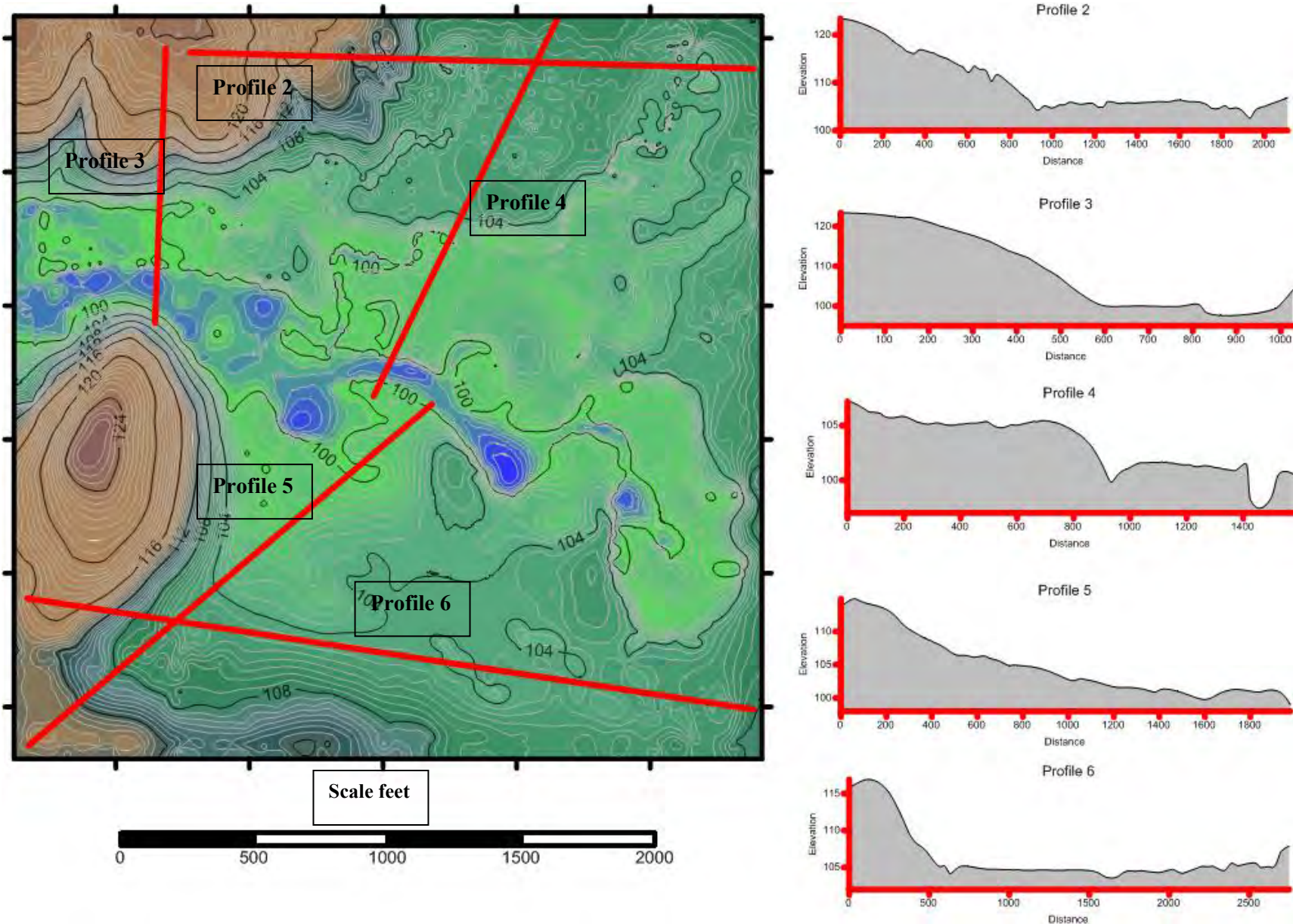


Figure 3.2 Topographic Profiles of Elevation Gradients



This topographic map illustrates the Laguna Creek watershed. The map features contour lines indicating elevation, with labels for 106, 108, 110, 112, 114, 116, 118, and 121 feet. Laguna Creek is shown in blue, and Frye Creek is shown in yellow. The map includes a scale bar from 0 to 2000 feet and a north arrow pointing upwards.

Figure 3.4 Existing Wetland Features Overlain on Catchment Boundaries

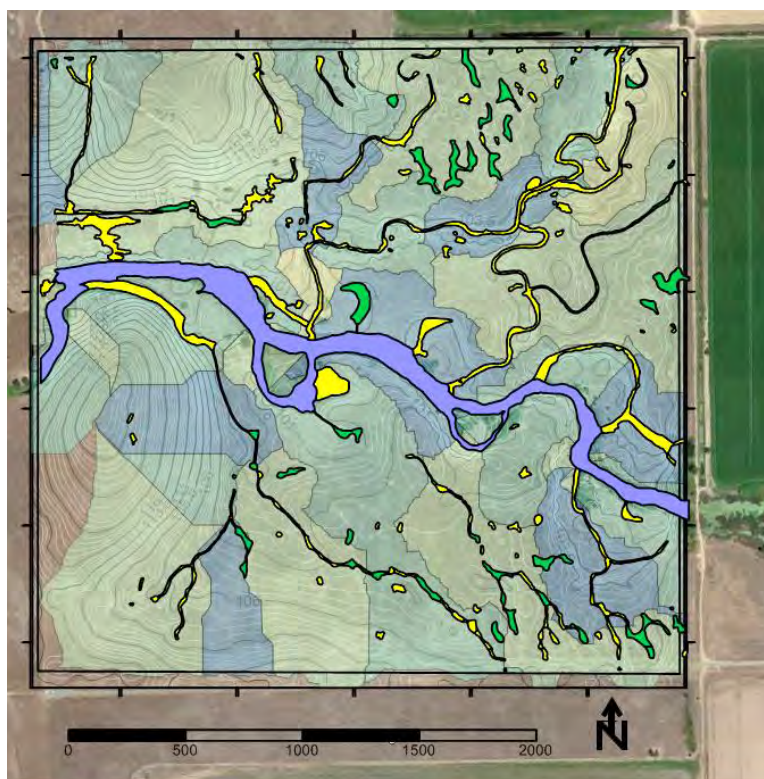


Figure 3.5 Gravitational Flow Vectors Associated with Topography and Existing Wetland Features

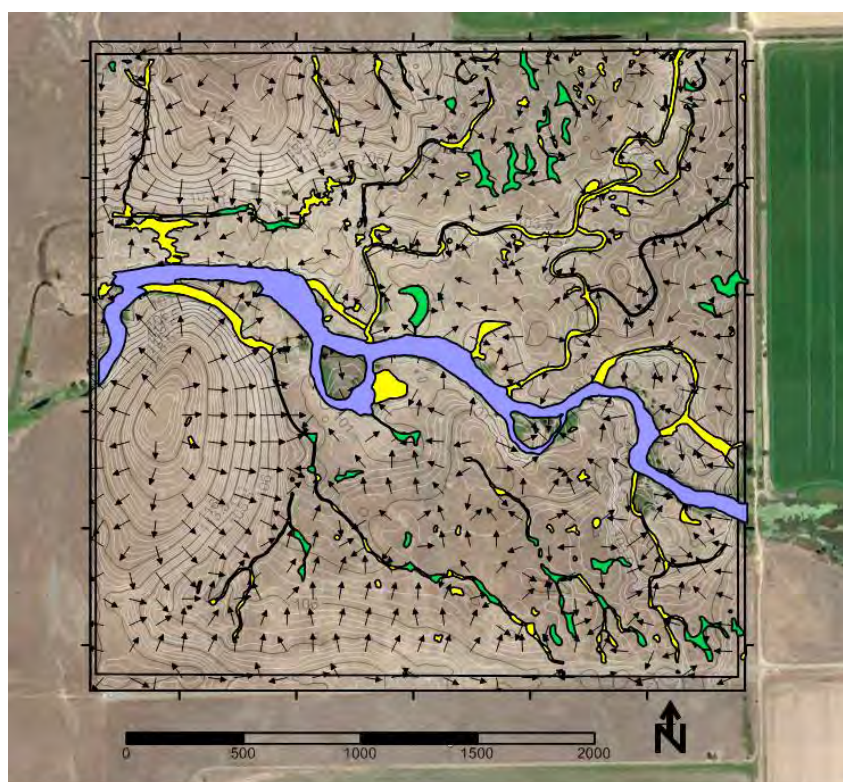
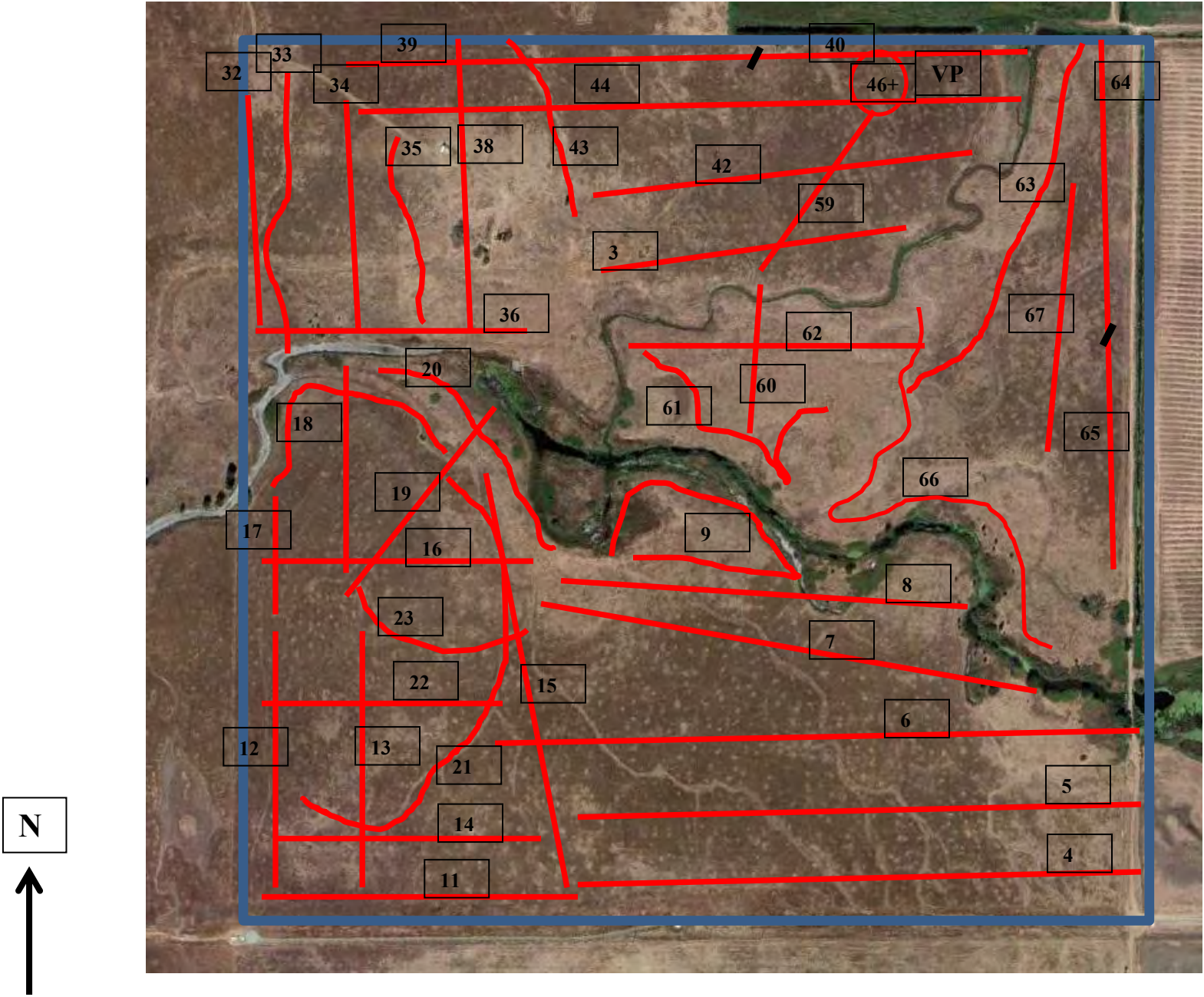


Figure 3.6 Ground-penetrating radar transects.



Legend	Property Boundary (approximate)	Ground-penetrating radar transect	GPR transect number (20)
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Figure 3.7 GPR Transect 39 West to East. Radargram wave data show colored view of positive and negative radar wave return signal. Density changes in soil cause stronger signals.

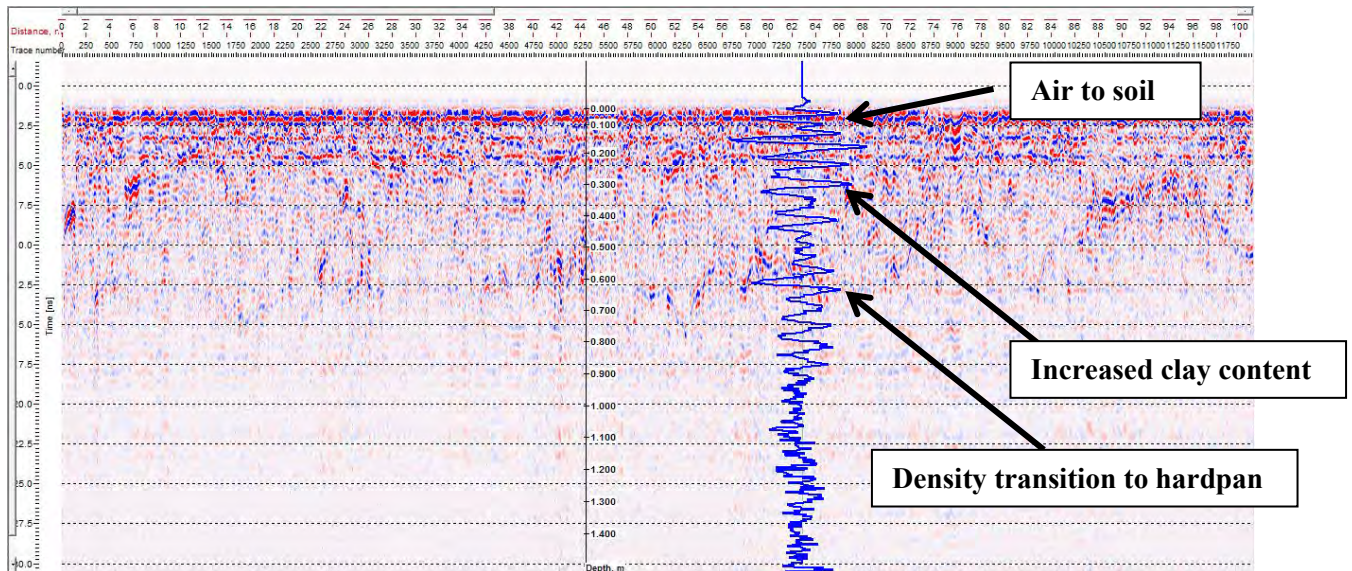


Figure 3.8 GPR Transect 39 West to East. Radargram showing reflection strength differences in the soil profile. Density changes in soil cause stronger signals.

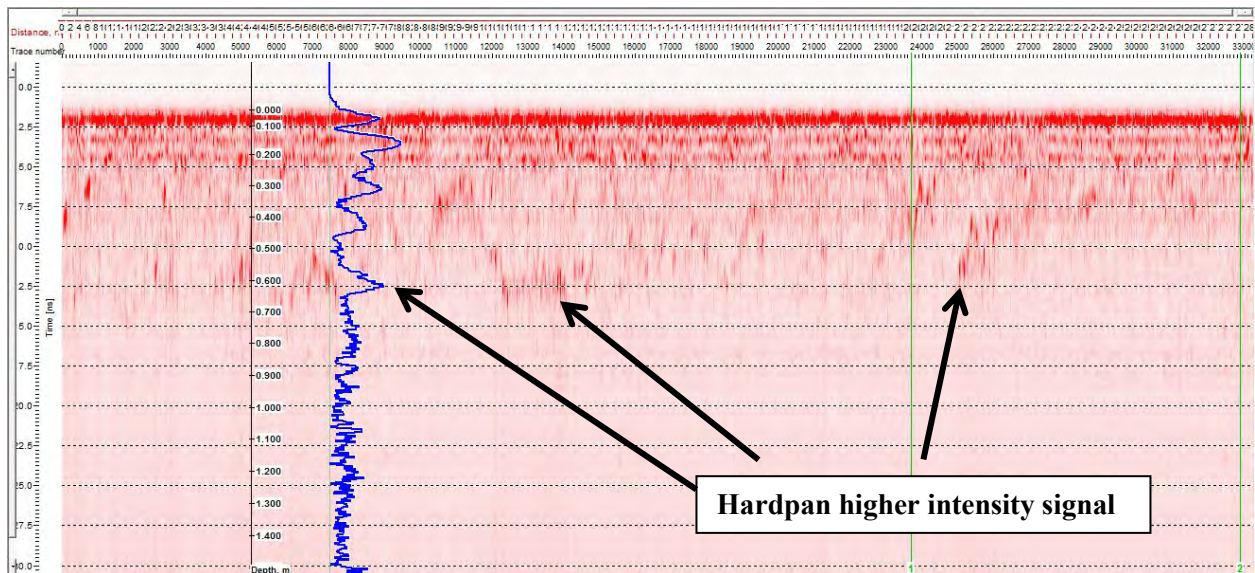


Figure 3.9 GPR transect 4 south side of Laguna Creek crossing a vernal pool – swale complex.

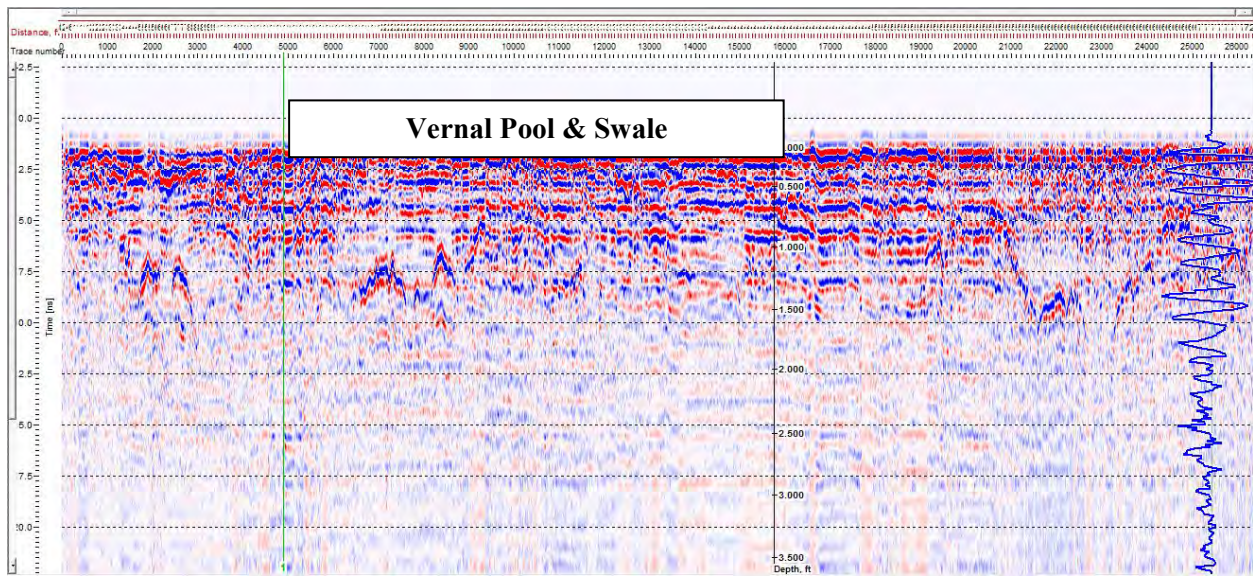


Figure 3.10 GPR transect 4 soil profile model south side of Laguna Creek crossing a vernal pool – swale complex.

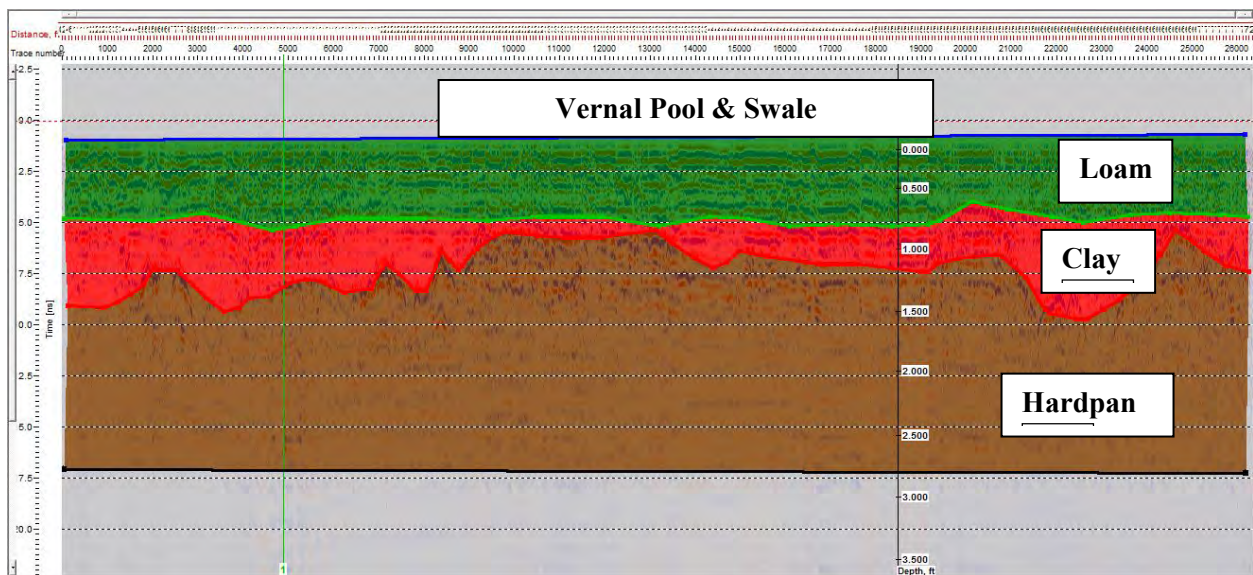


Figure 3.11 Natural Vernal Pool East Side (DAT 117) San Joaquin Soil Series

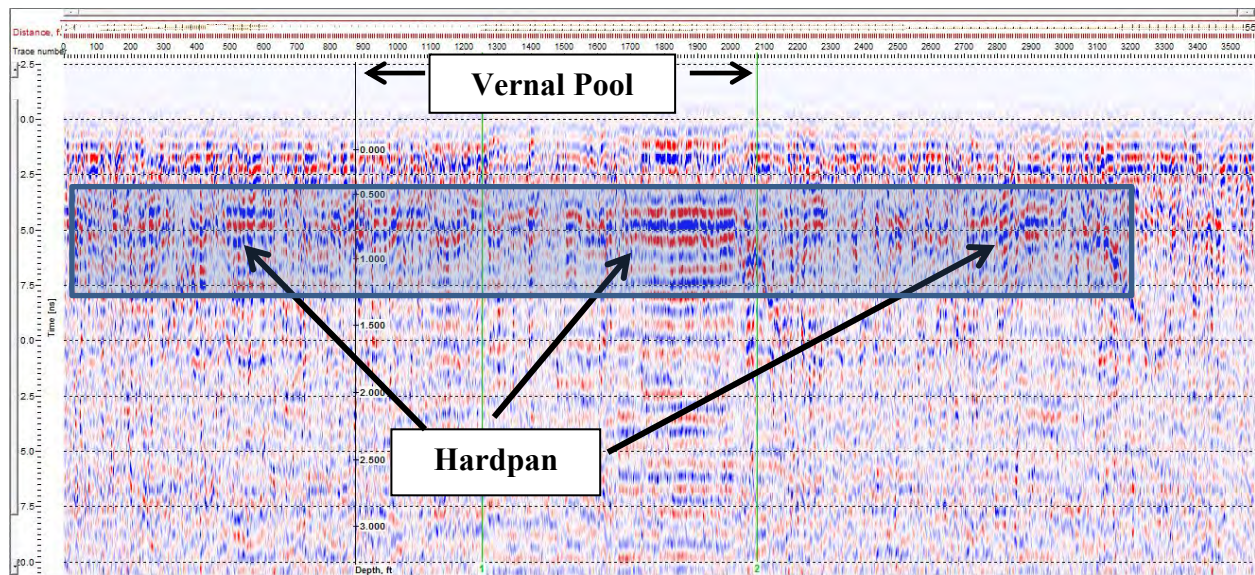


Figure 3.12 Natural Vernal Pool GPR (DAT 129) San Joaquin Soil Series

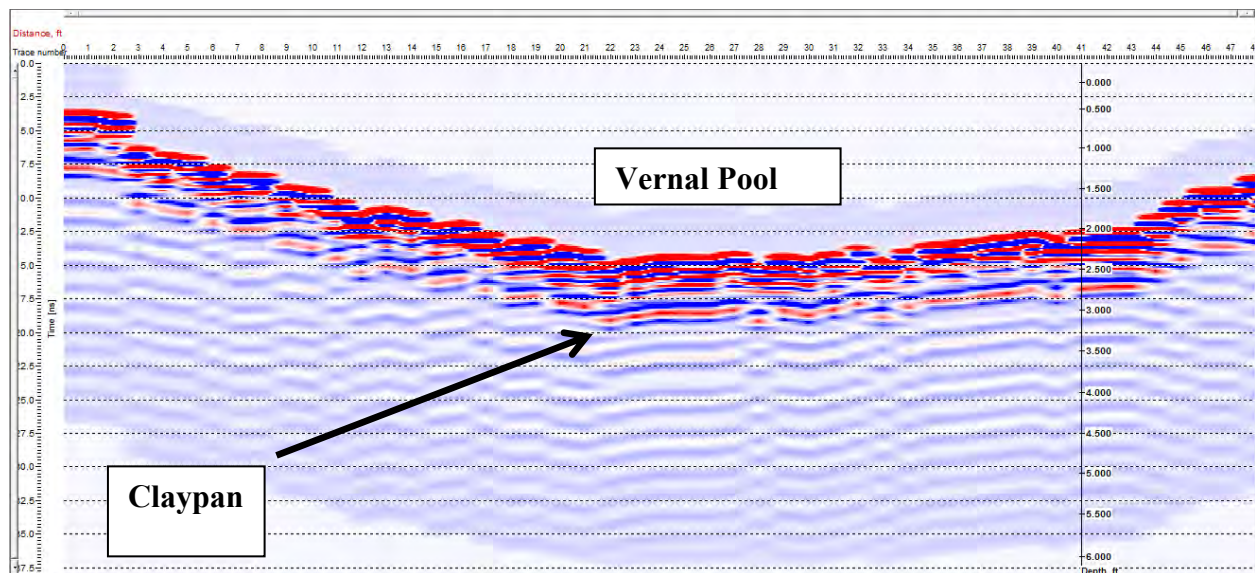


Figure 3.13 Natural Vernal Pool GPR (DAT 131) Hedge Soil Series

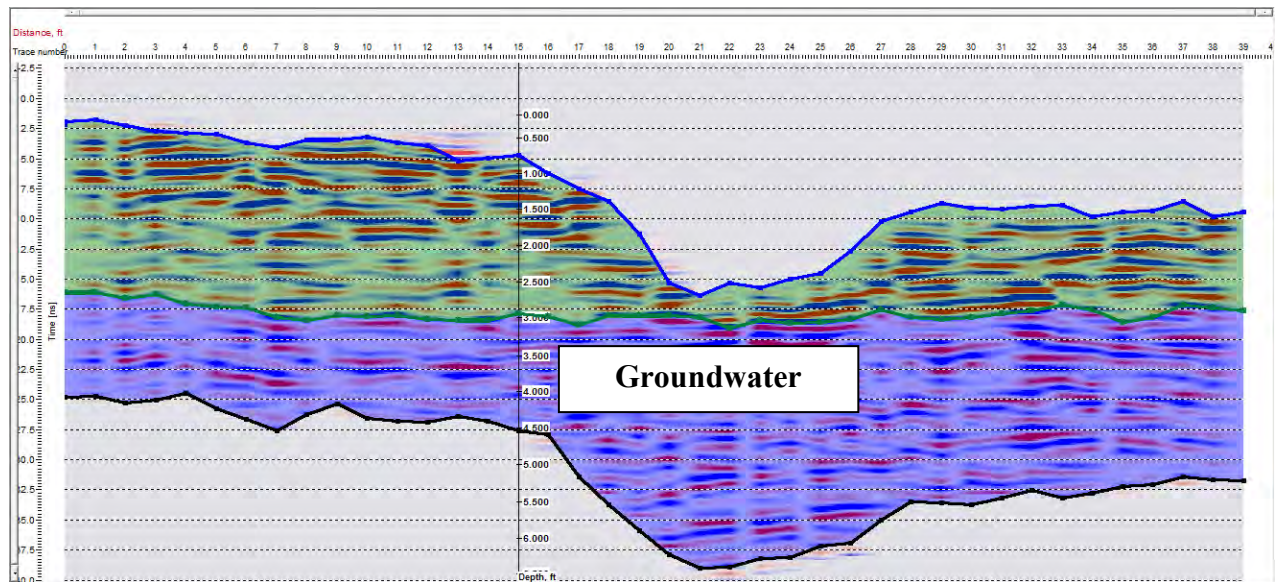


Figure 3.14 GPR (DAT 21) along toe of slope on south side of Laguna Creek follows a small drainage

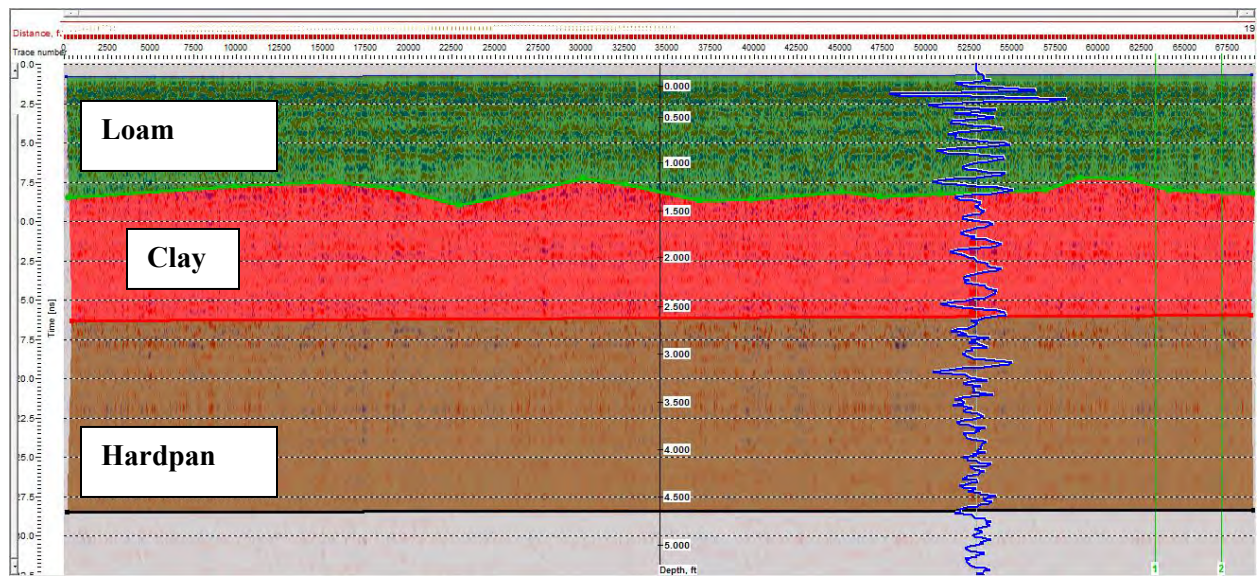


Figure 3.15 GPR Transect (DAT 006) South of Laguna Creek

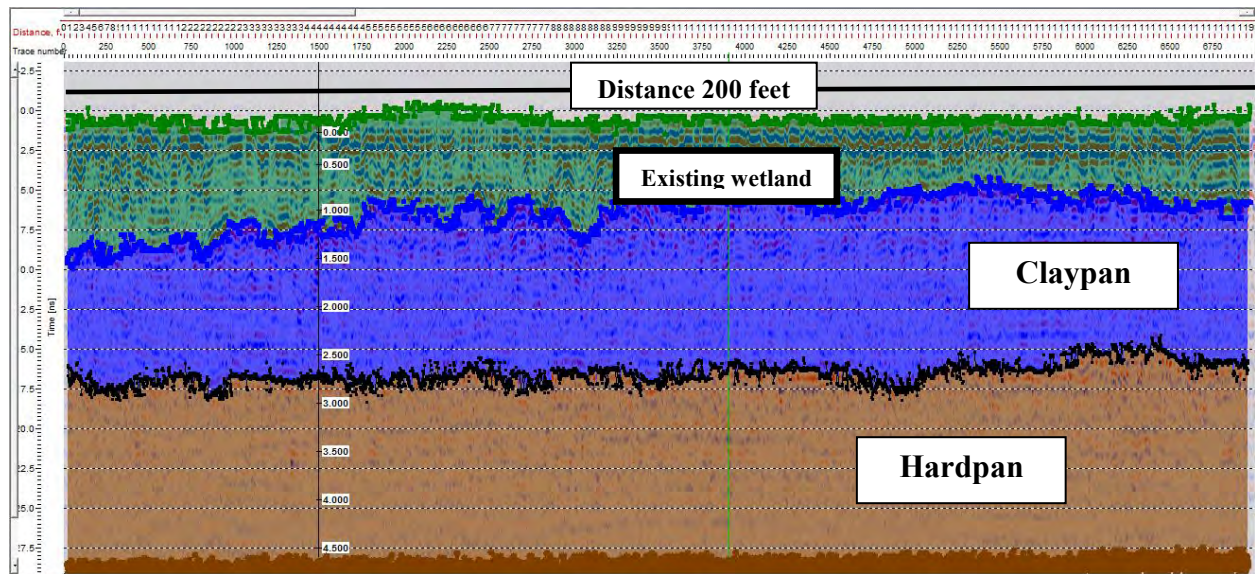


Figure 3-16 Catchments with Cascading Vernal Pool Basins

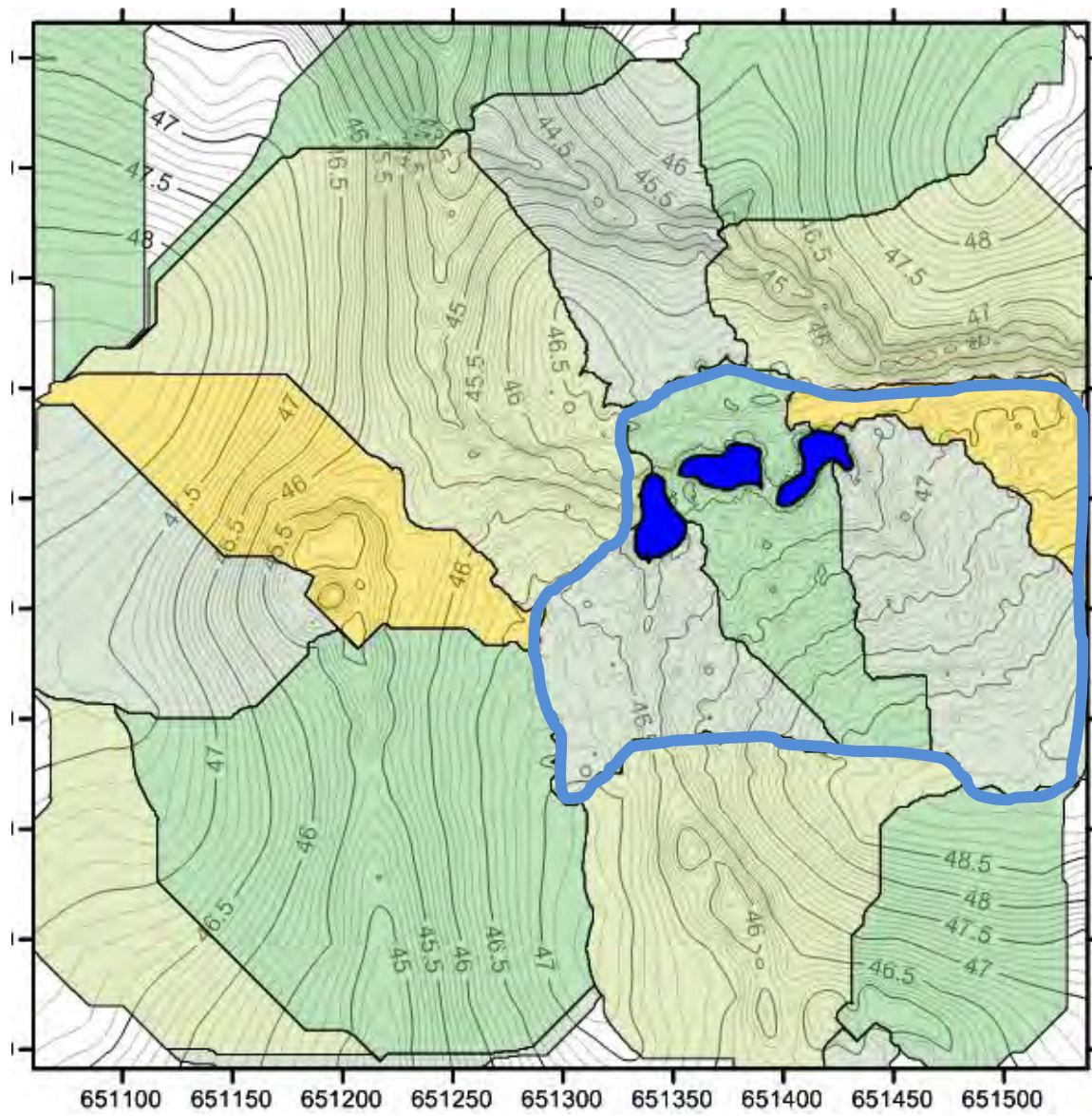


Figure 3.17 Vernal Pool Landscape Cross-Section.. (Copyright Institute for Ecohydrology Research).

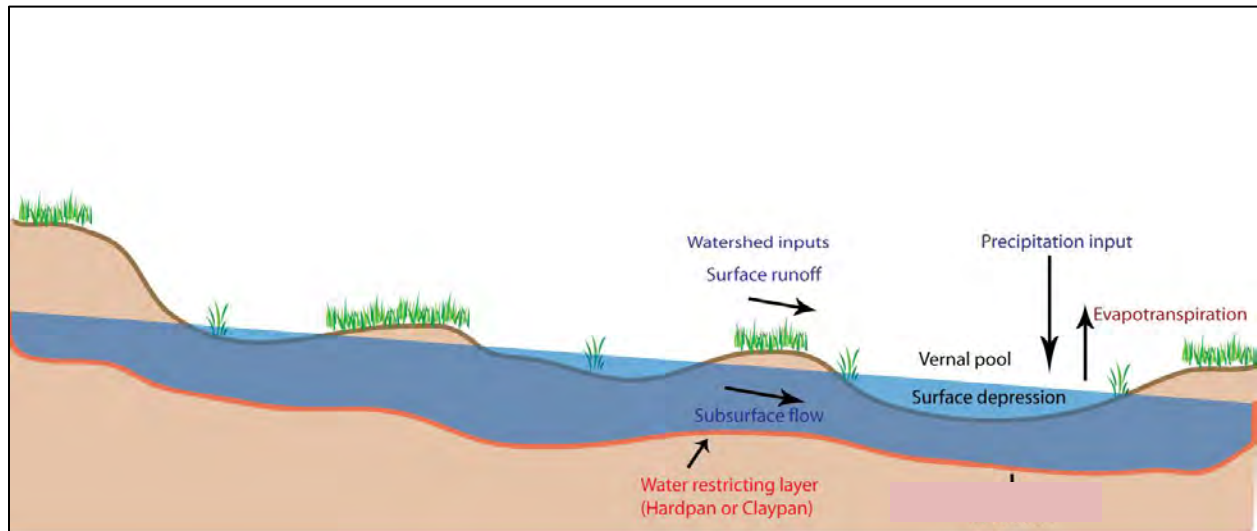


Figure 3.18 Cross-Section of Vernal Pool Landscape Showing Components of Water Input from Rainfall (P) and Subsurface (Q_{gi}) and Surface (Q_{si}) Catchment Discharge and Outputs from Evapotranspiration (ET) and Downslope Subsurface (Q_{go}) and Surface (Q_{so}) Discharge Out. (Copyright Institute for Ecohydrology Research).

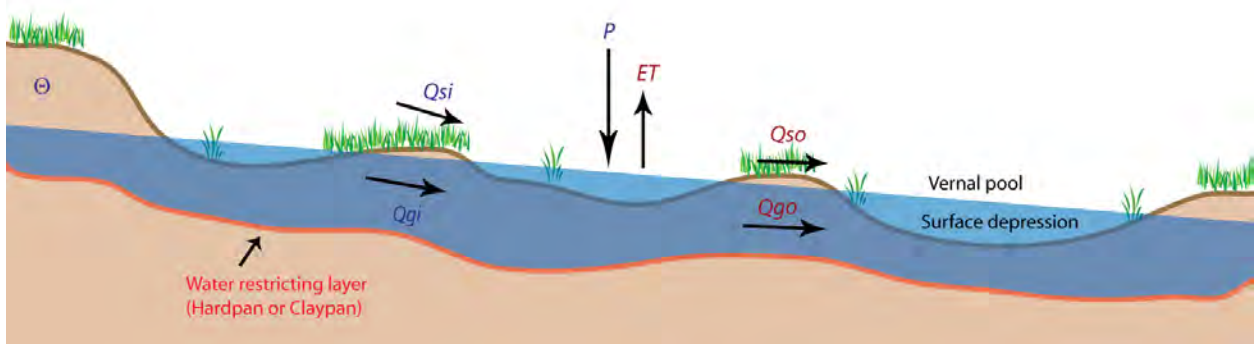


Figure 3.19 Annual Rainfall Sacramento, California

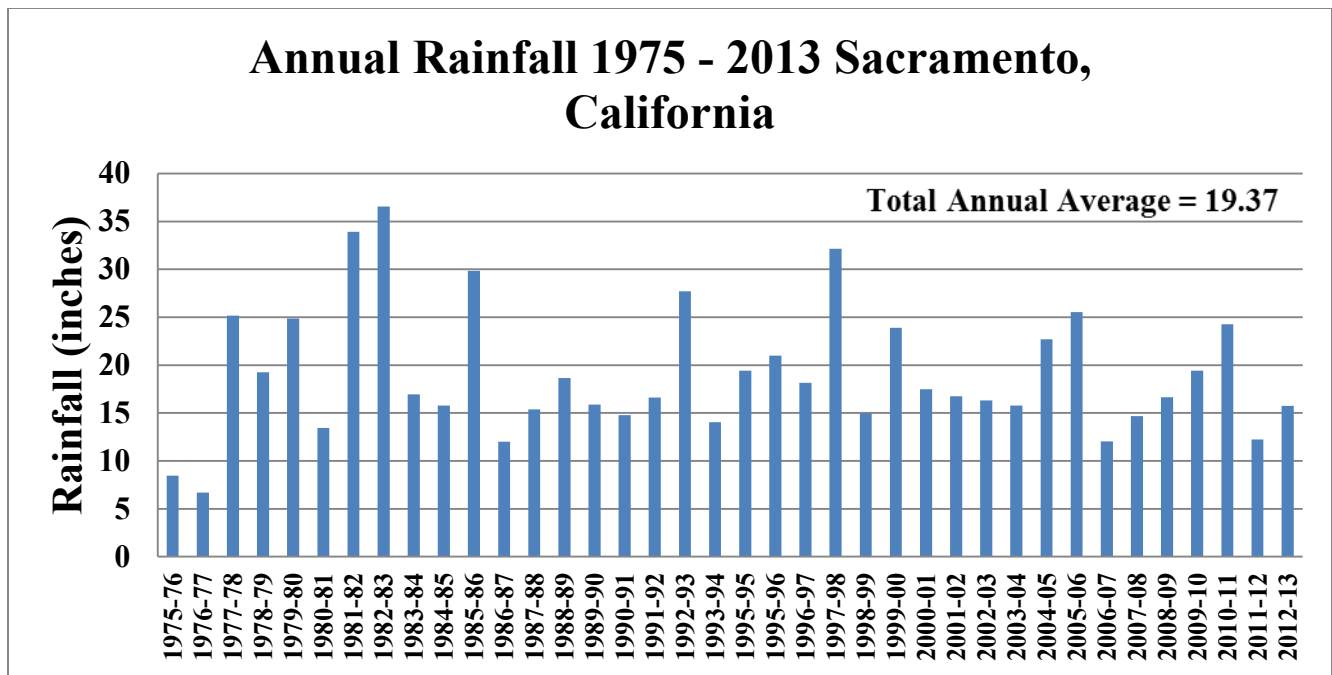


Figure 3.20 Monthly Average Distribution of Rainfall Sacramento, California

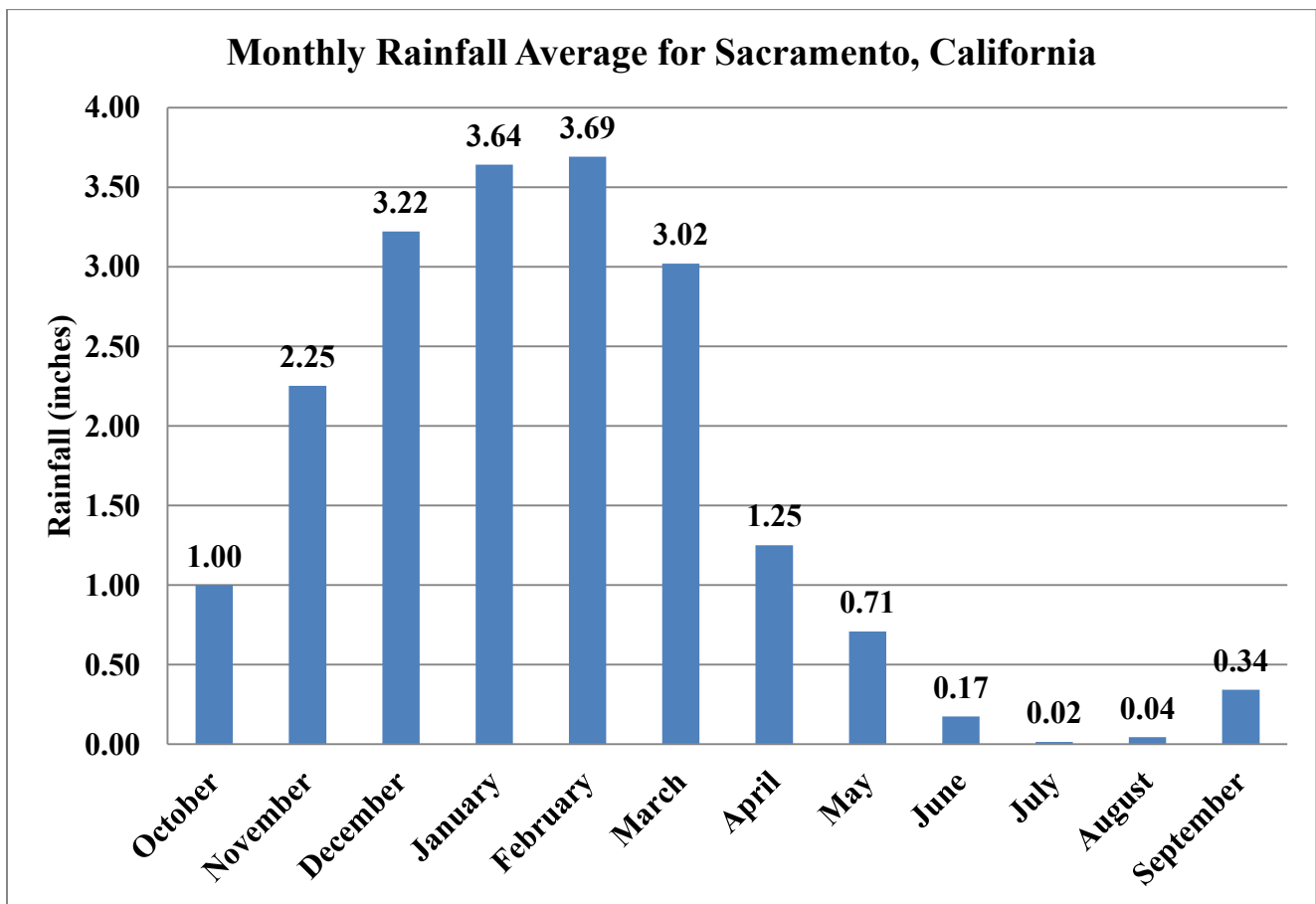
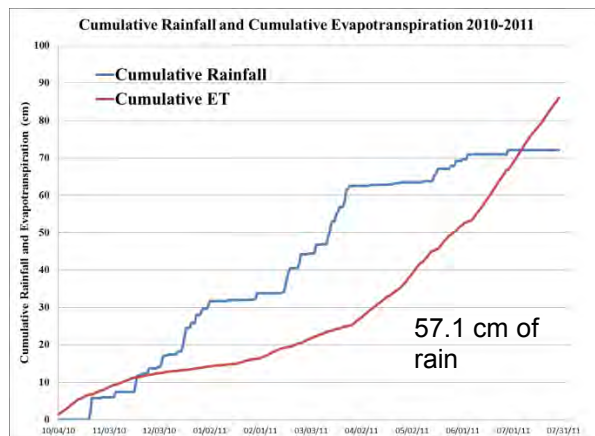
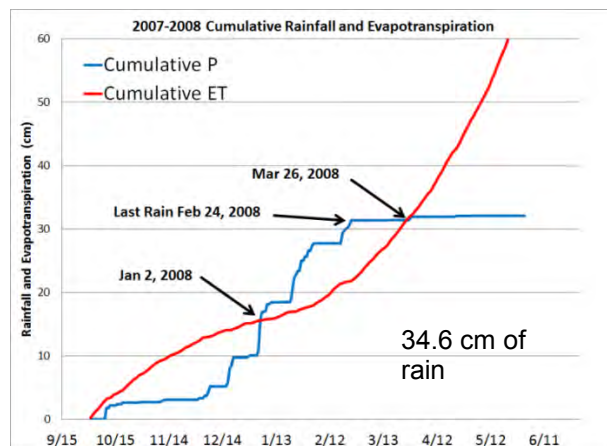
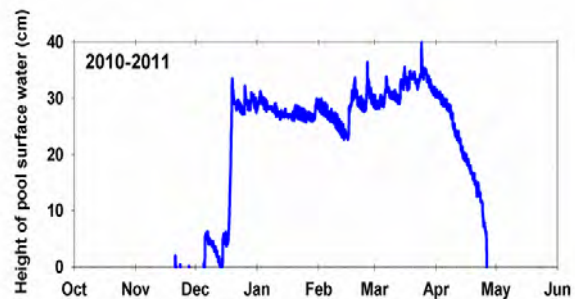


Figure 3.21 Comparison of Rainfall and Evapotranspiration with Natural Vernal Pool Hydrographs Showing How the Water Balance of Water Input from Rain and Water Loss from Evapotranspiration Determines the Hydroperiod. (Data analysis from McCarten and Christman 2013 with hydrographs from vernal pools at Mather Field, Sacramento Co., California).



143 days of Inundation



83 days of Inundation

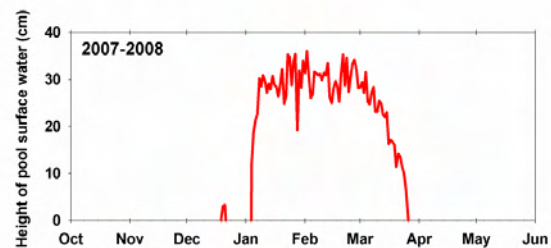
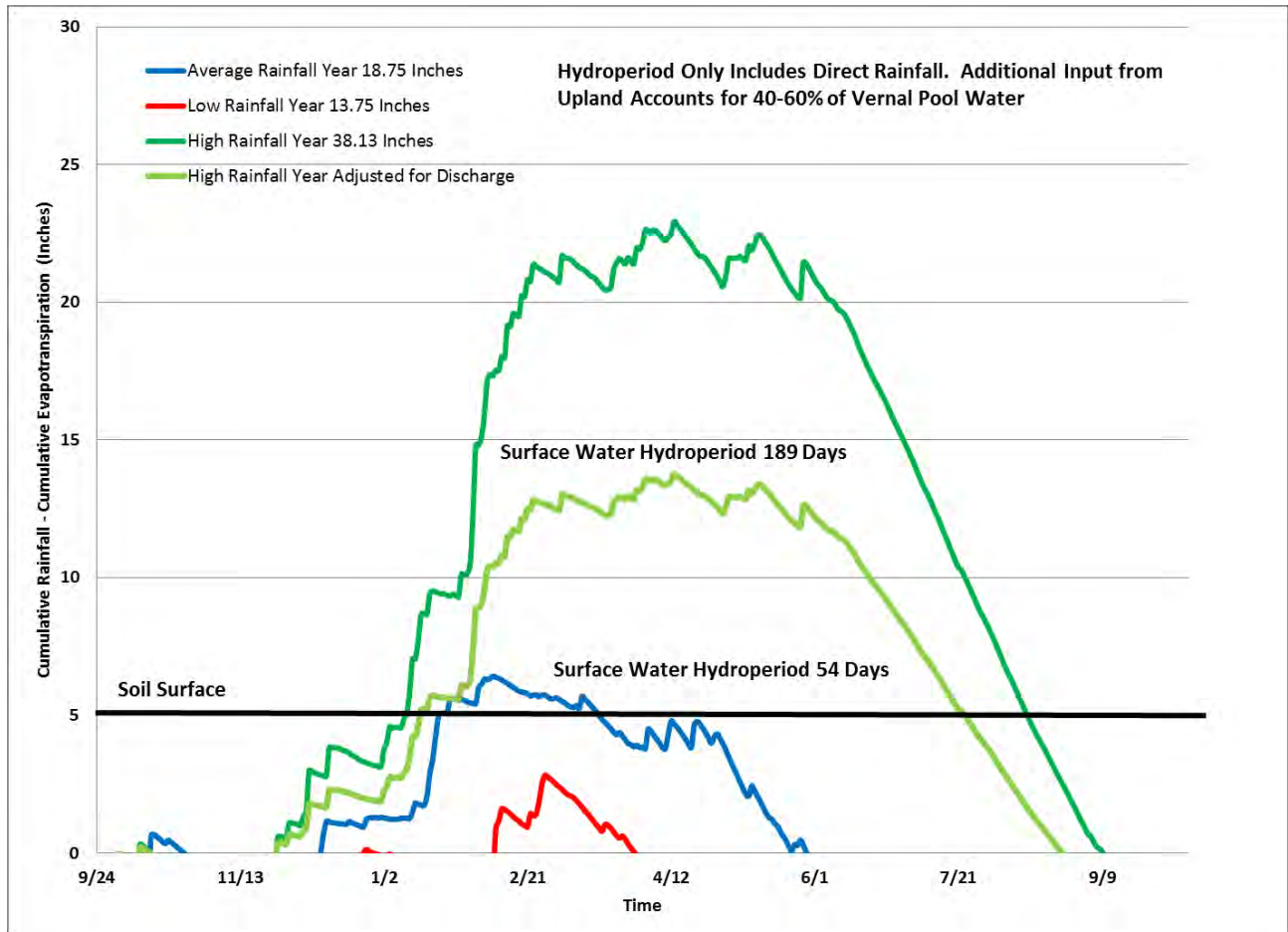


Figure 3.22 Potential Hydrograph During Average Rainfall Year (2009-2010), Dry Rainfall Year (2006-2007), and Wet El Niño Rainfall Year (1997-1998).



Section 4

Figure 4.1 Proposed Creation Vernal Pools

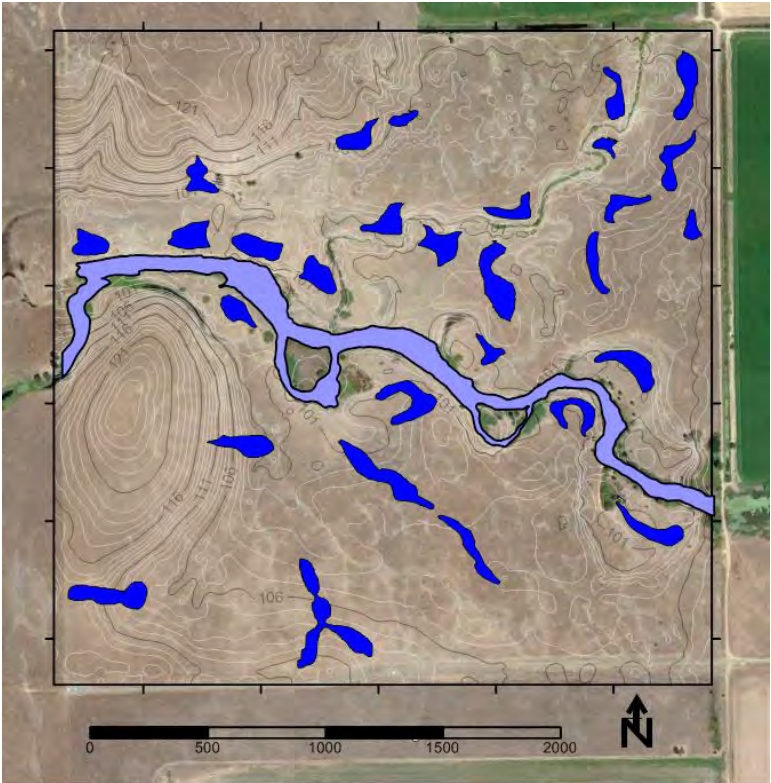


Figure 4.2 Proposed Creation Vernal Pools Numbered for Listing in Table with Acreage

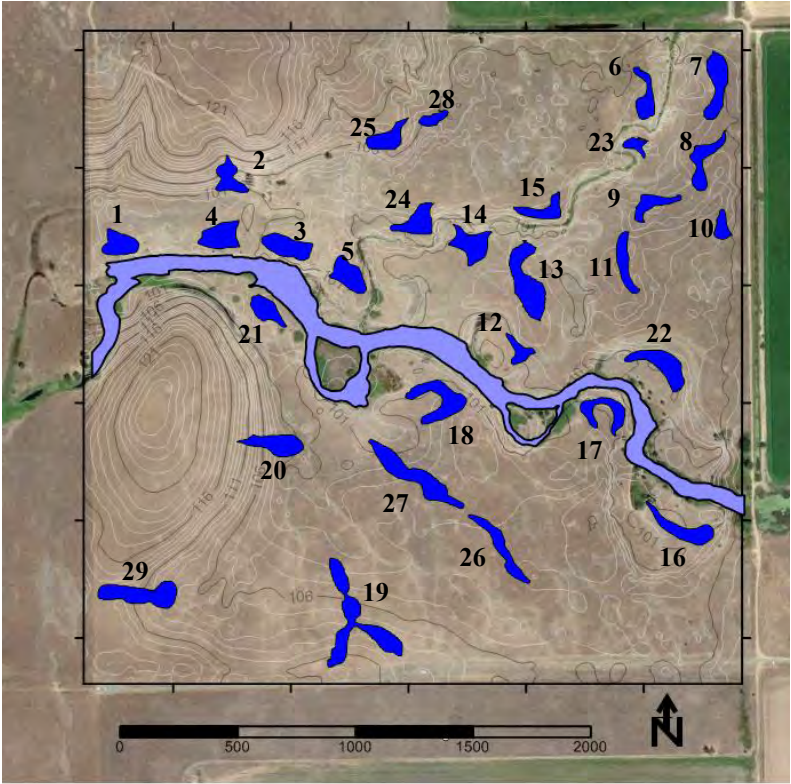


Figure 4.3 Proposed Creation Vernal Pools (blue) with Existing Wetland Features Including Vernal Pools (green), and seasonal wetlands and swales (yellow)

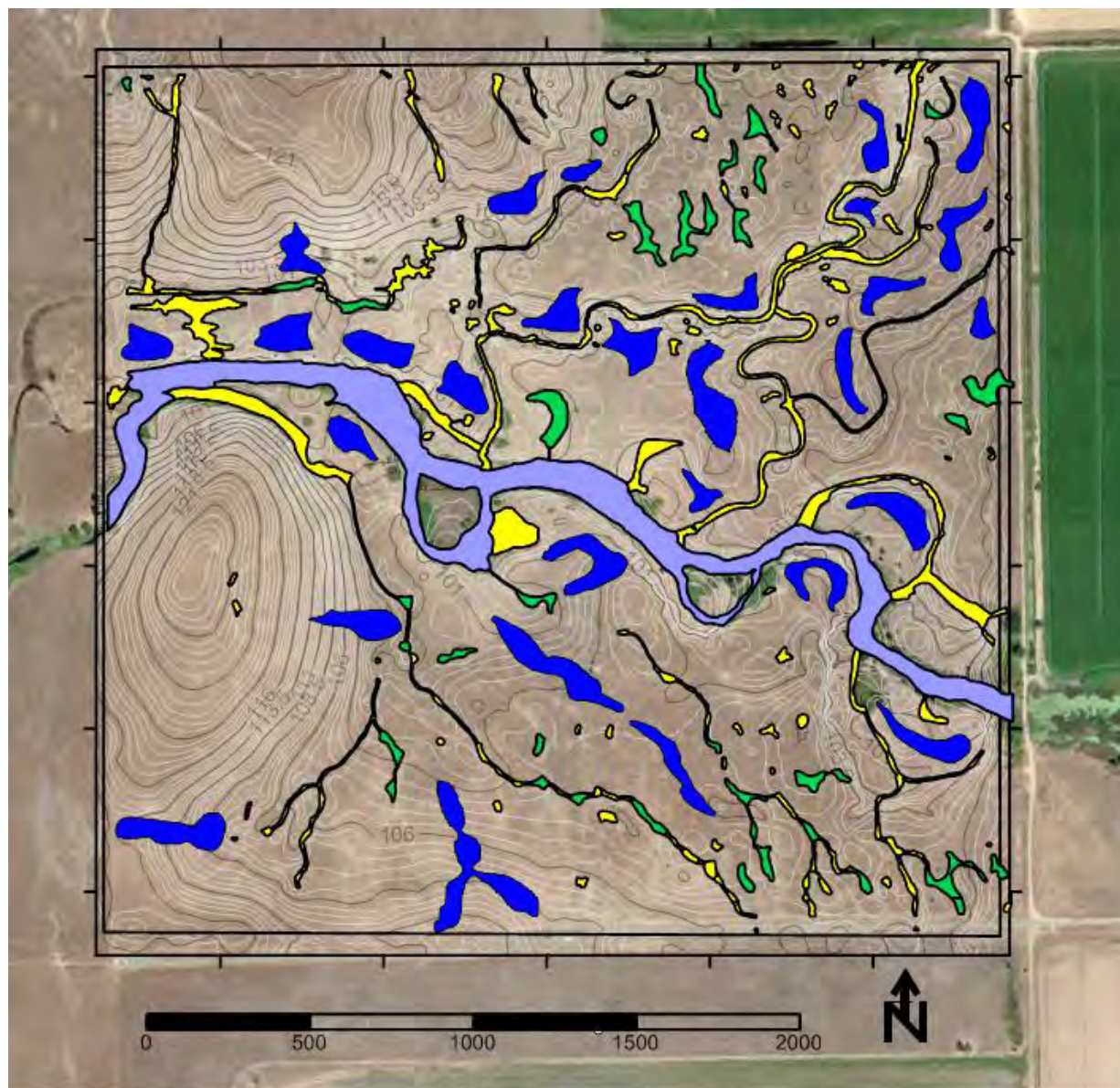


Figure 4.4 Proposed Creation Vernal Pools and Existing Wetland Features Overlaying the Catchment Boundaries

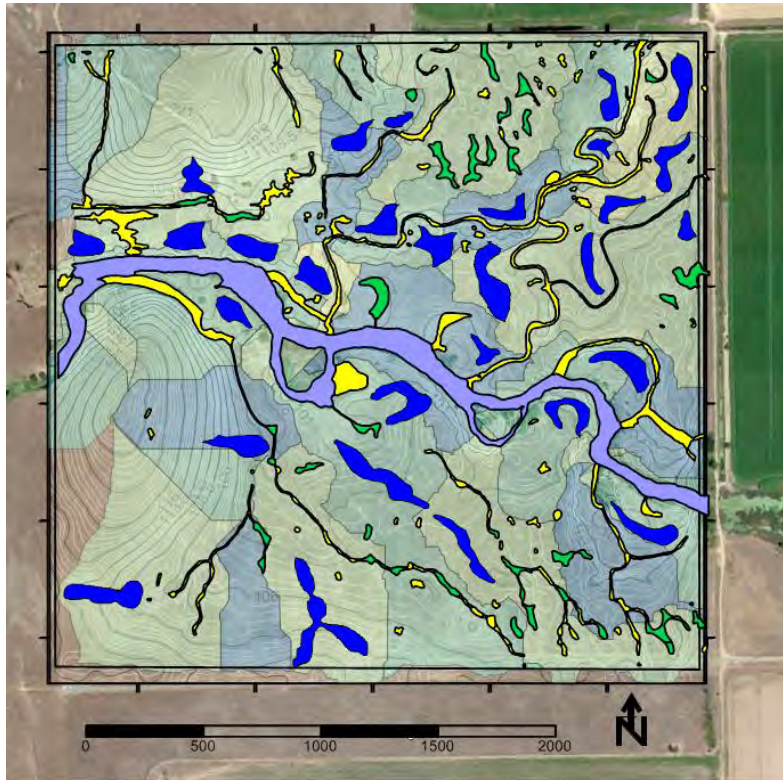


Figure 4.5 Existing Wetlands and Created Wetlands with Vector Flow Arrows

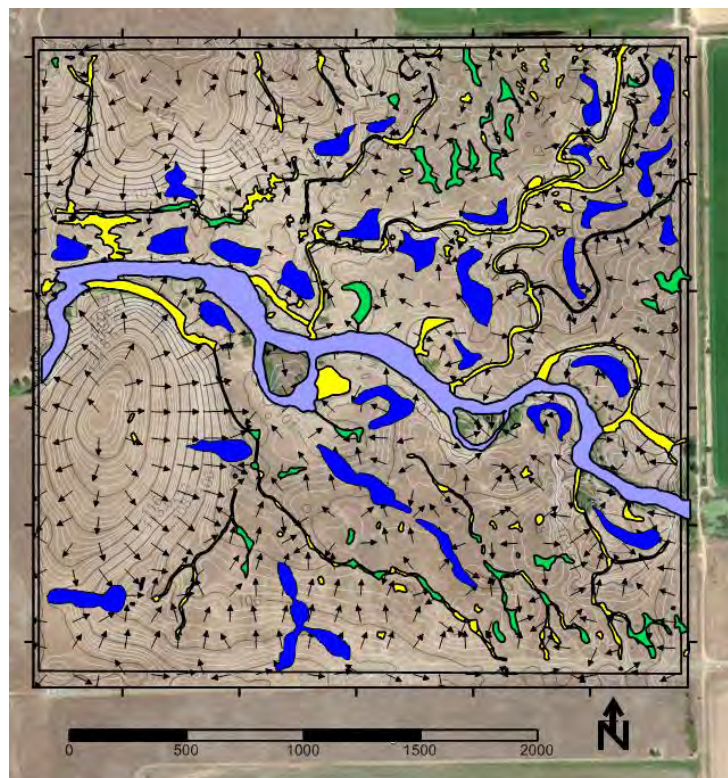
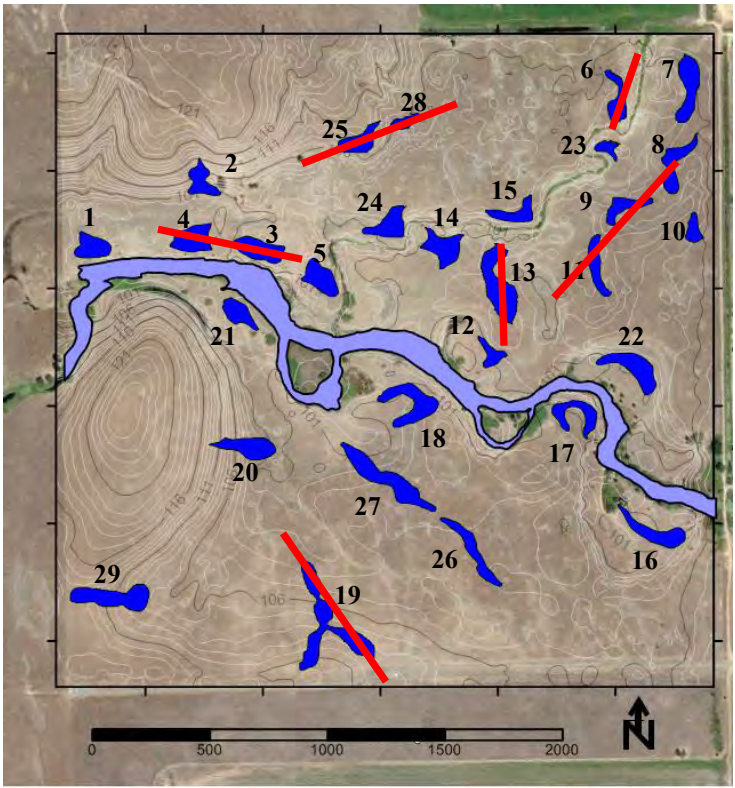


Figure 4.6 GPR Transects across Representative Proposed Created Vernal Pool Sites (GPR data and cross-sections are available for all proposed created vernal pools. The ones identified here are representative of the range of vernal pool soil profiles).



Legend: Proposed created vernal  **Black numbers refer to individual pools**
GPR transects 

Figure 4.7A GPR Transect (DAT 105) Potential Vernal Pool Creation Area Pools 3 and 4

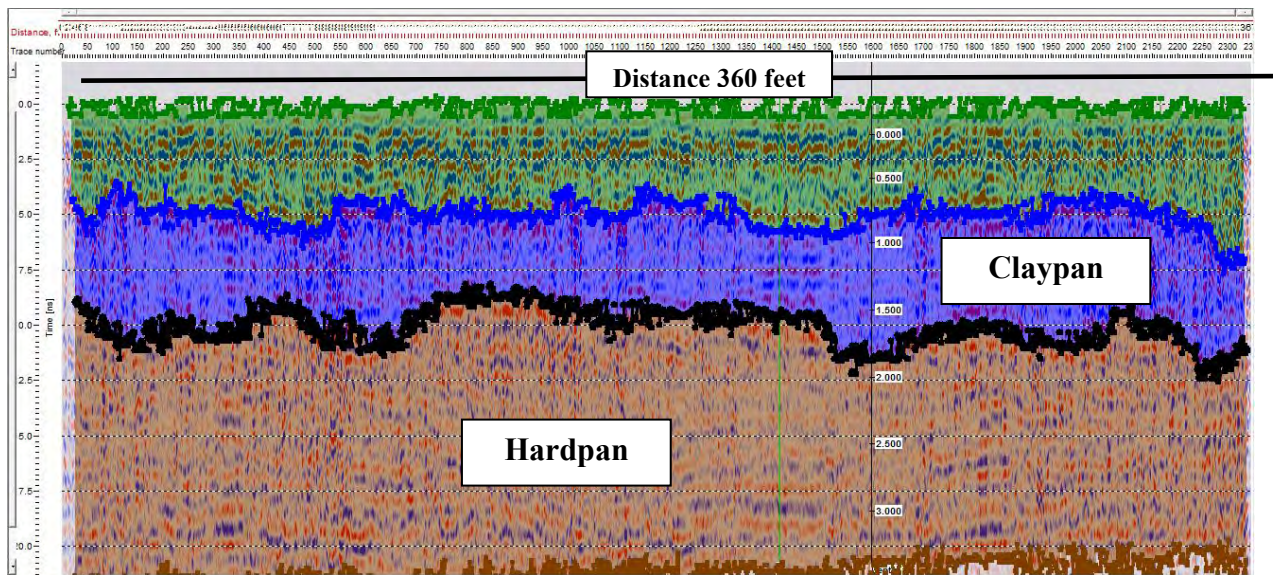


Figure 4.7B Cross Section Showing Proposed Pools 3 and 4.

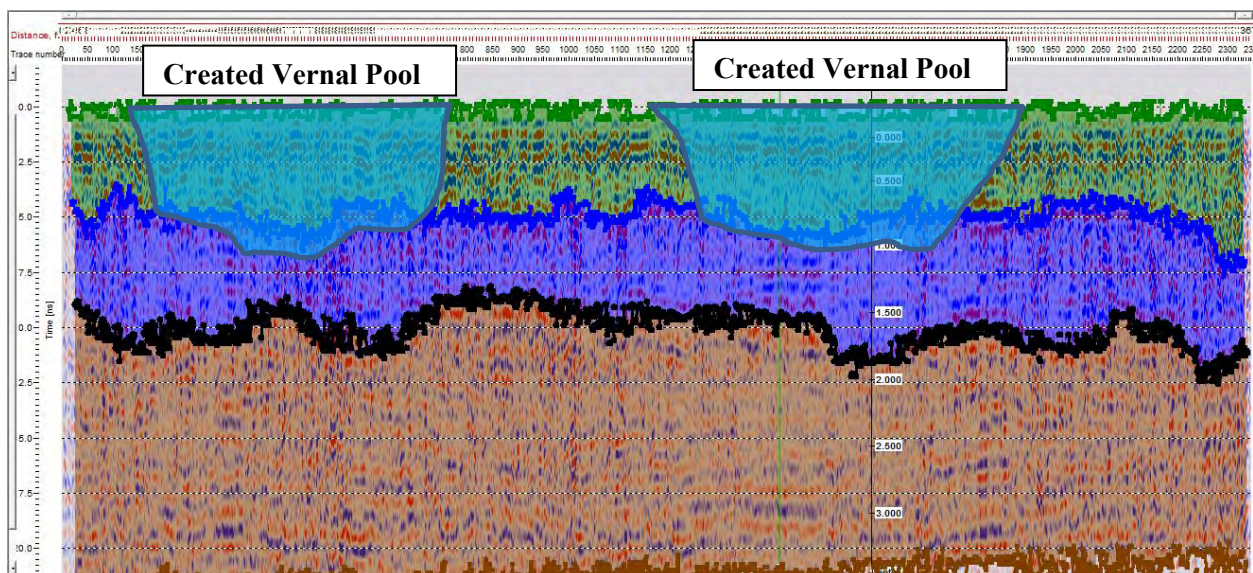


Figure 4.8 A GPR Transect (DAT 118) East Side Through Proposed Vernal Pool Creation Area Pools 8, 9, 11.

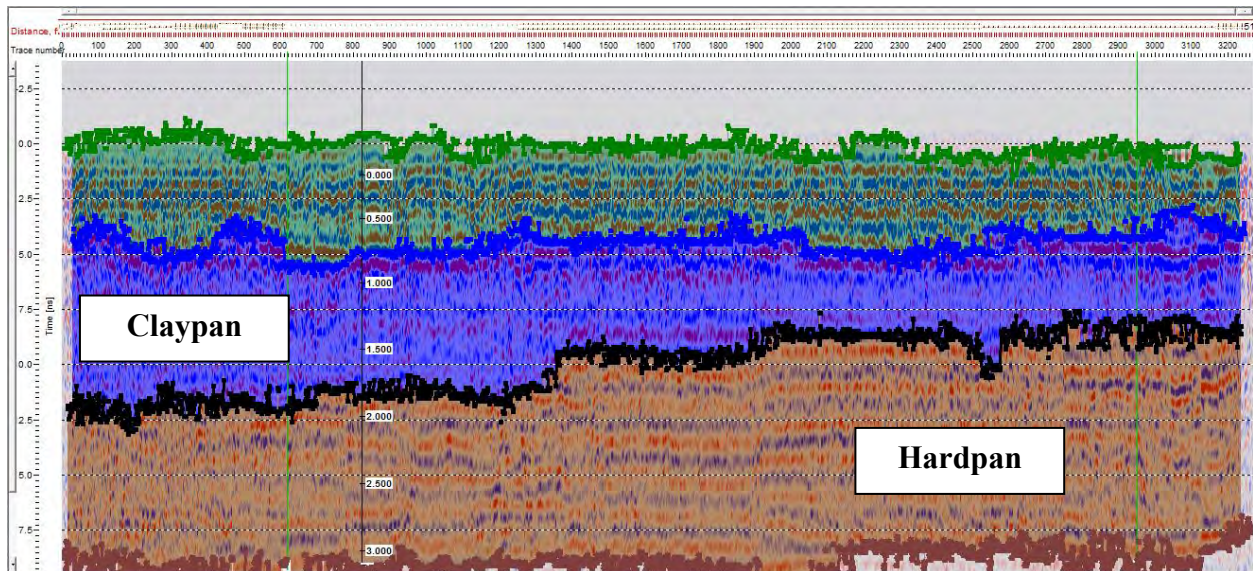


Figure 4.8 B Cross Section Showing Proposed Pools

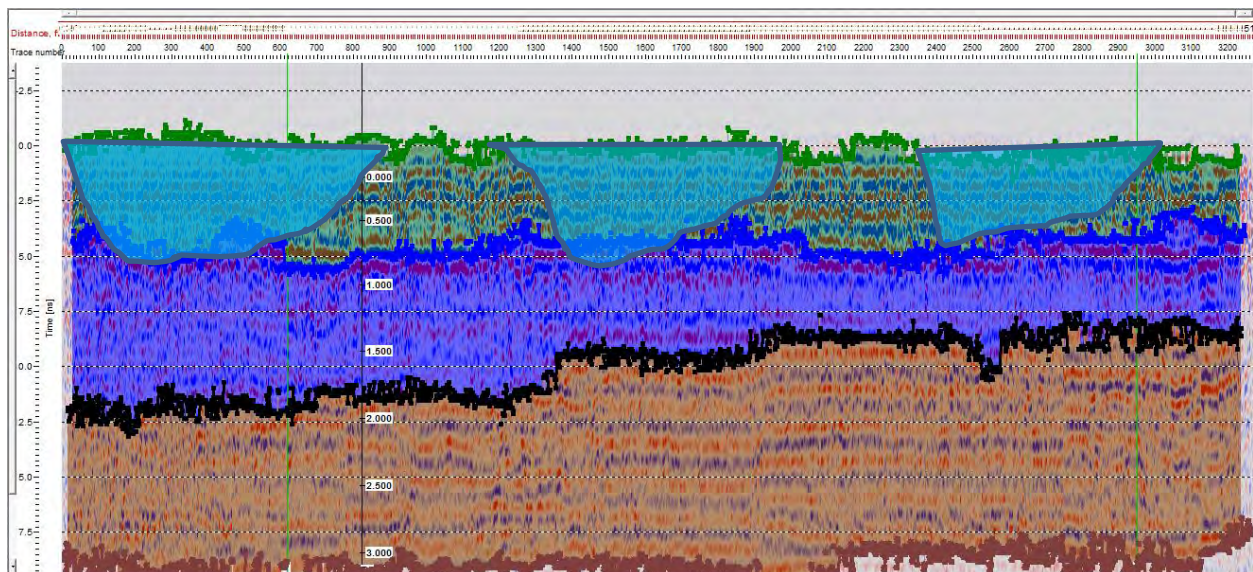


Figure 4.9 A GPR Transect (DAT 111) Proposed Vernal Pool Creation Area Pool 6

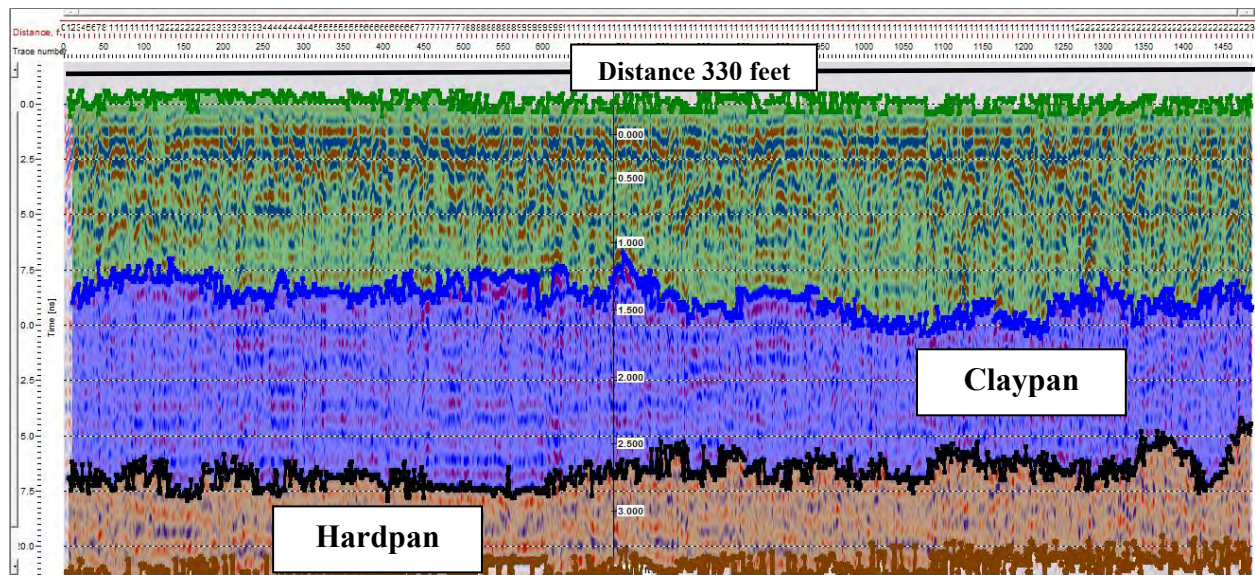


Figure 4.9B GPR Cross Section Showing Proposed Pool 6

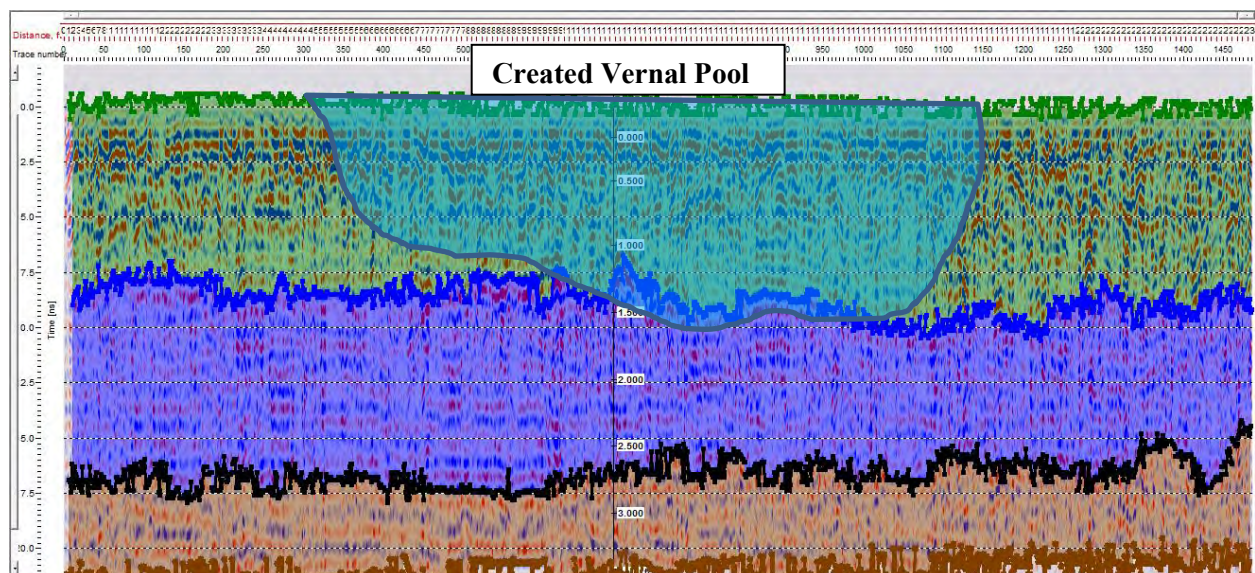


Figure 4.10A GPR Transect DAT 109 Potential Vernal Pool Restoration Area Pool 13

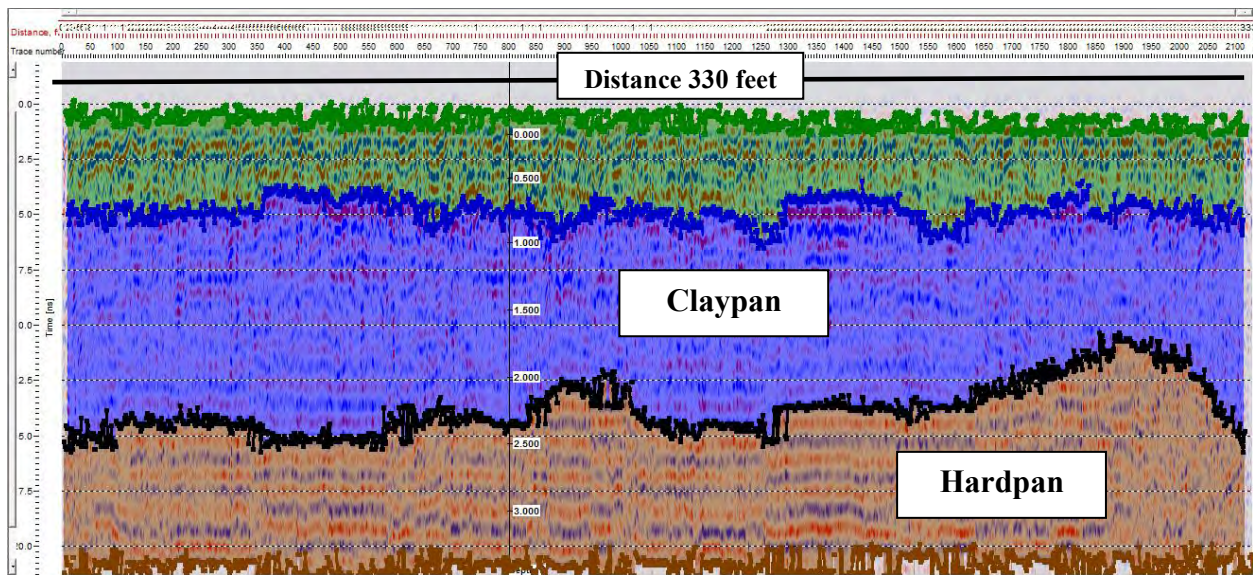


Figure 4.10B Cross Section of Proposed Creation Vernal Pool 13

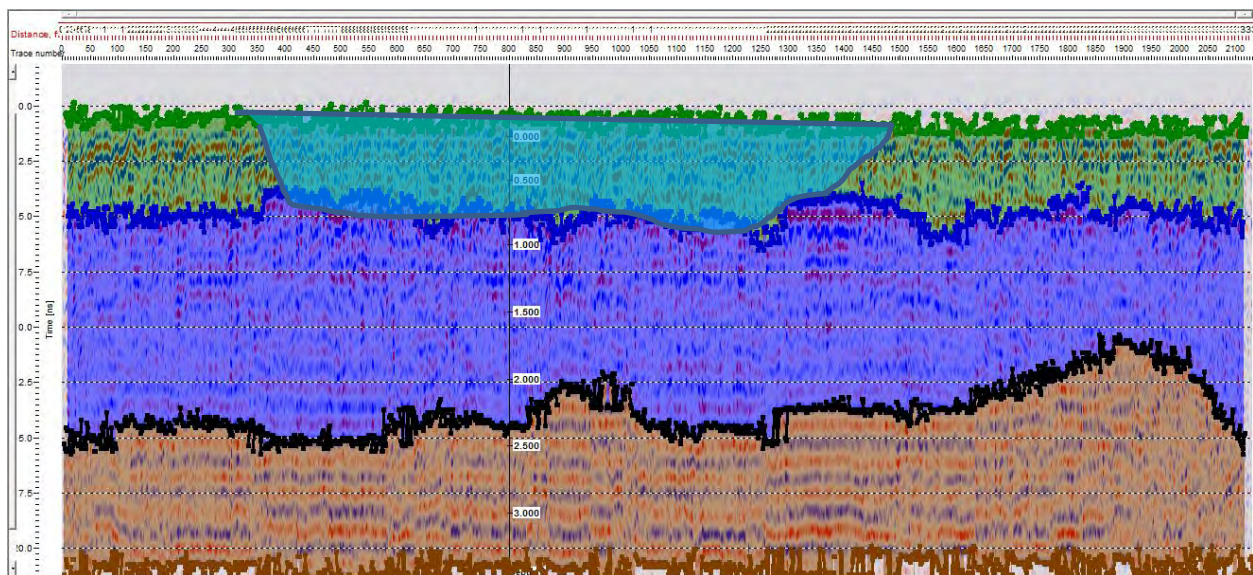


Figure 4.11A GPR Transect (DAT 015) Proposed Vernal Pool Creation Area Pool 19

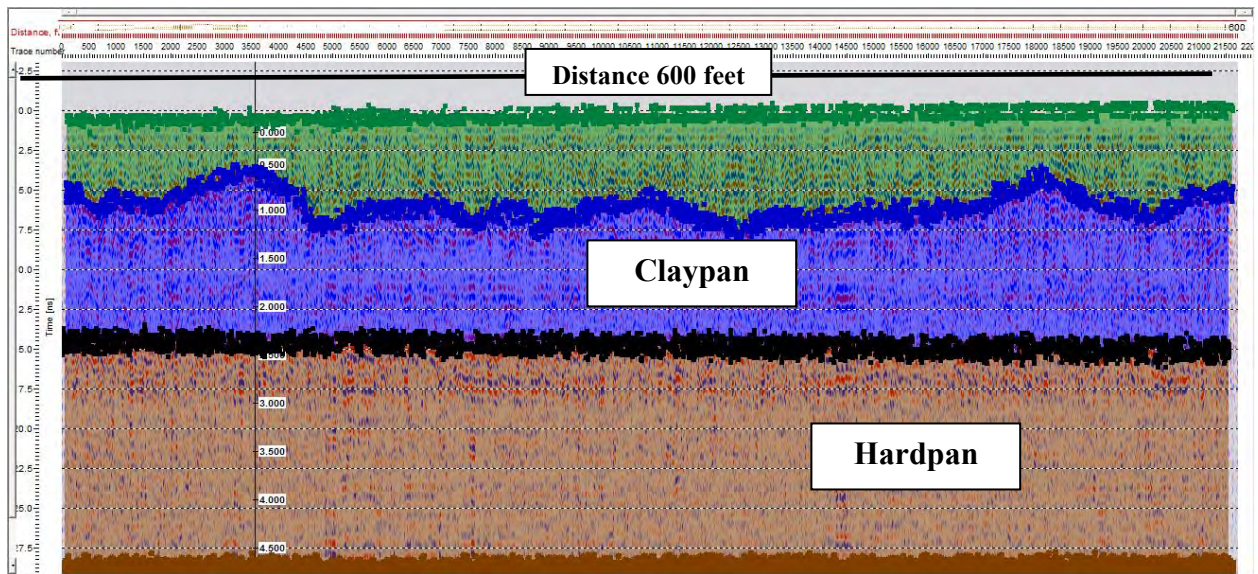


Figure 4.11 B Cross Section of Proposed Creation Vernal Pool 19

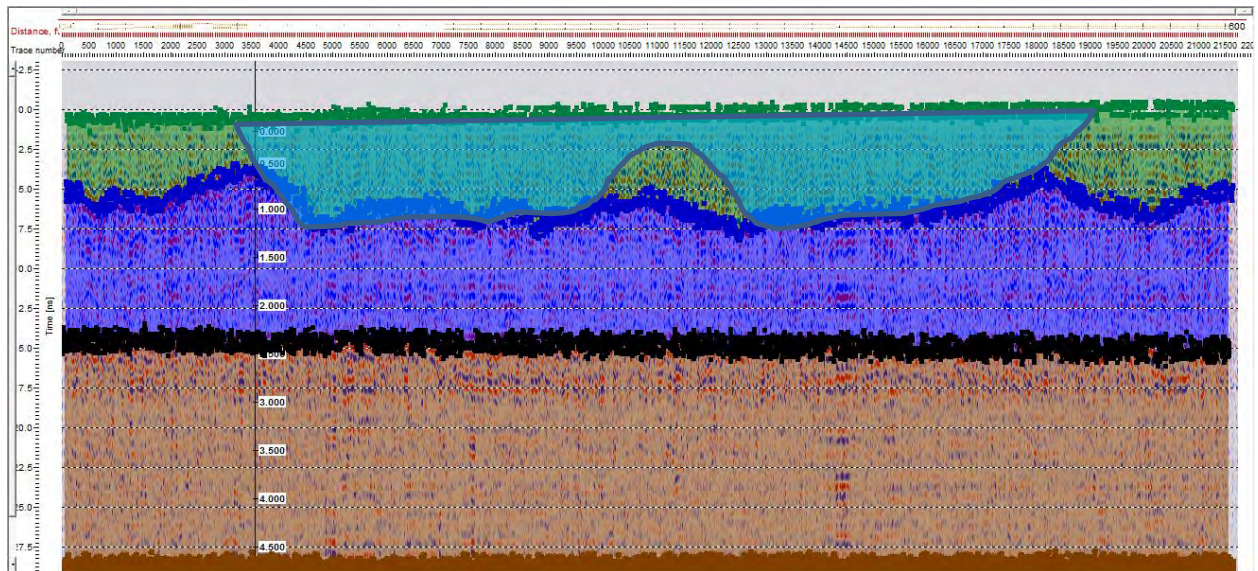


Figure 4.12A GPR Transect (DAT 99) Proposed Vernal Pool Creation Pools 25 and 28

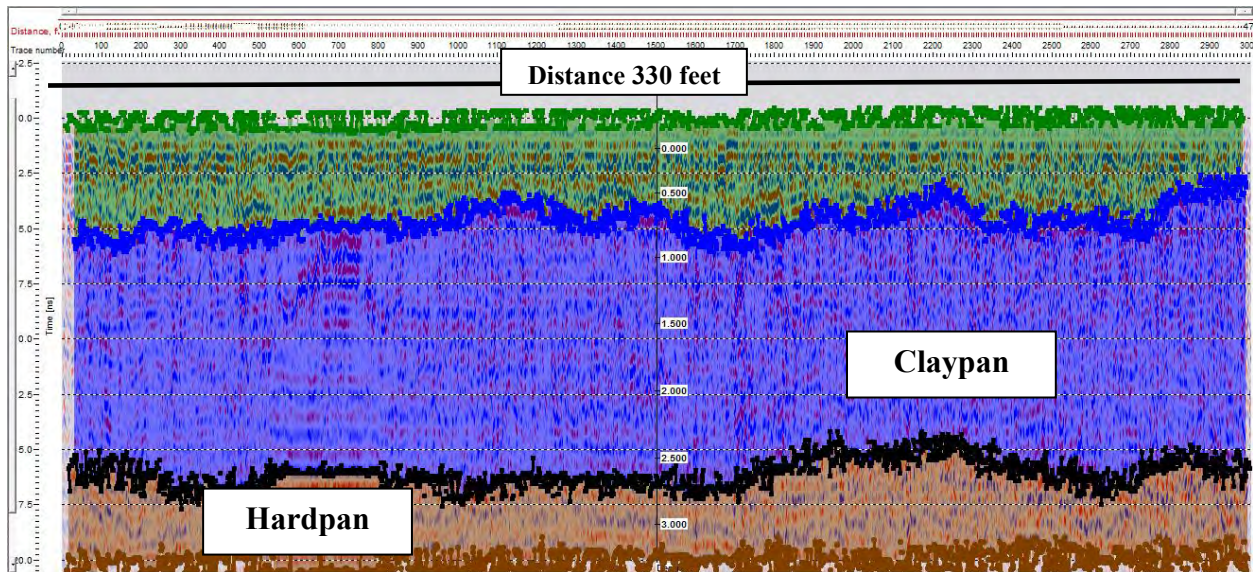
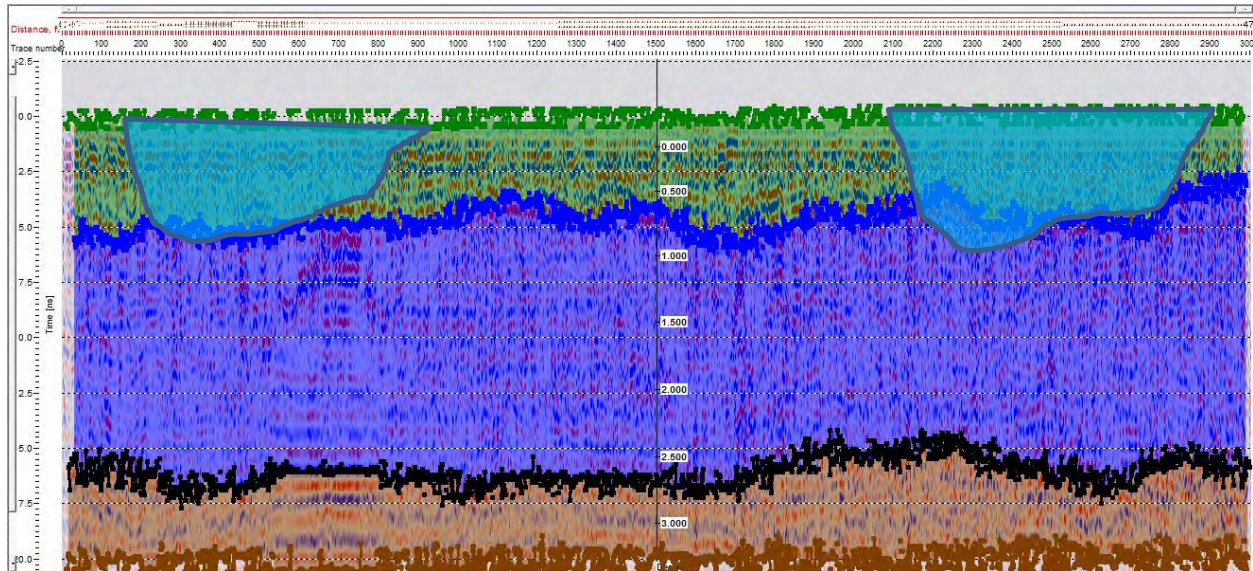


Figure 4.12 B Cross Section of Proposed Created Vernal Pools 25 and 28



Section 5

Figure 5.1 Vernal Pool Monitoring Using Hourly Datalogging Pressure Transducers Established on the Water-Restricting Layer of Created and Natural Reference Pools.

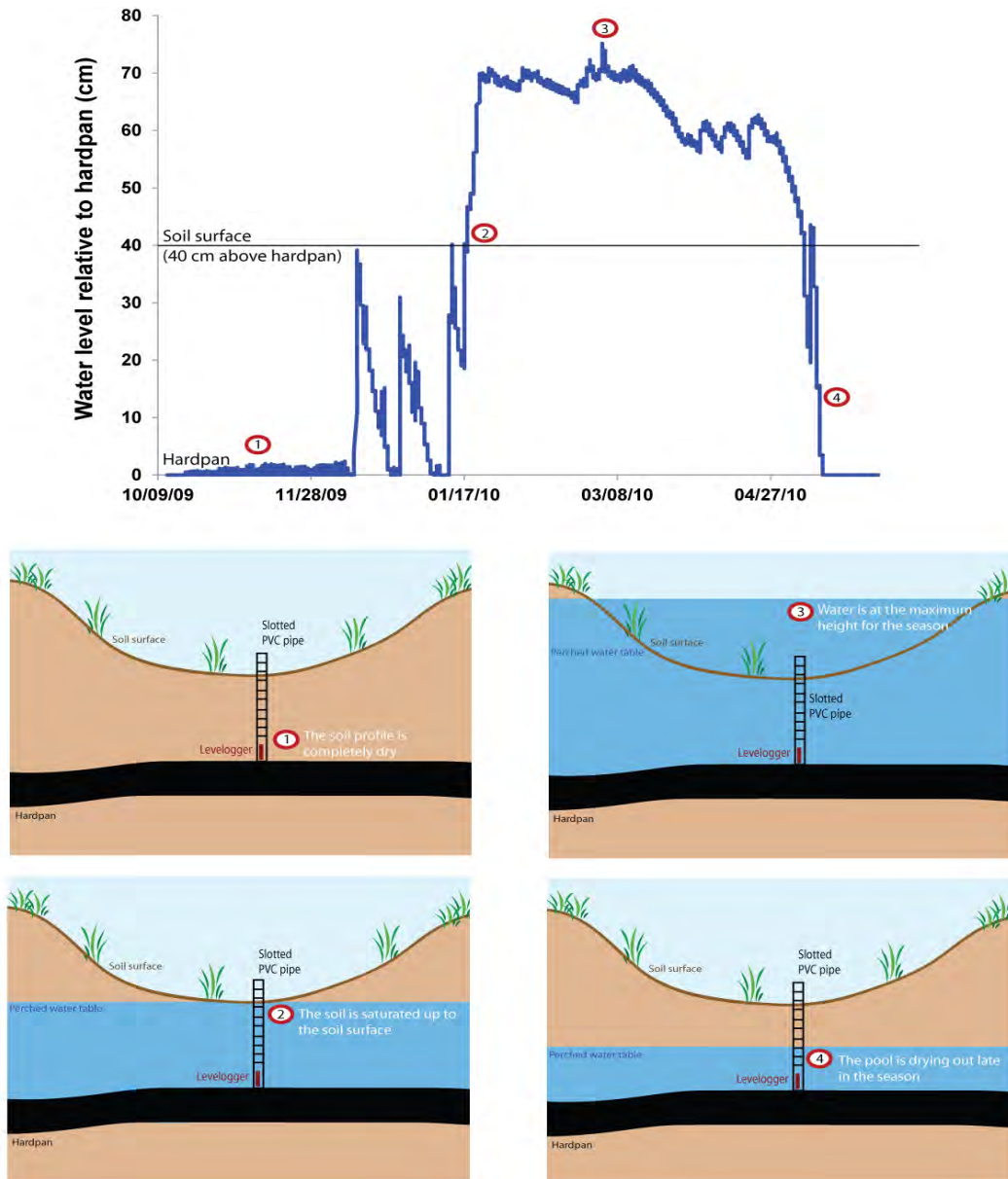
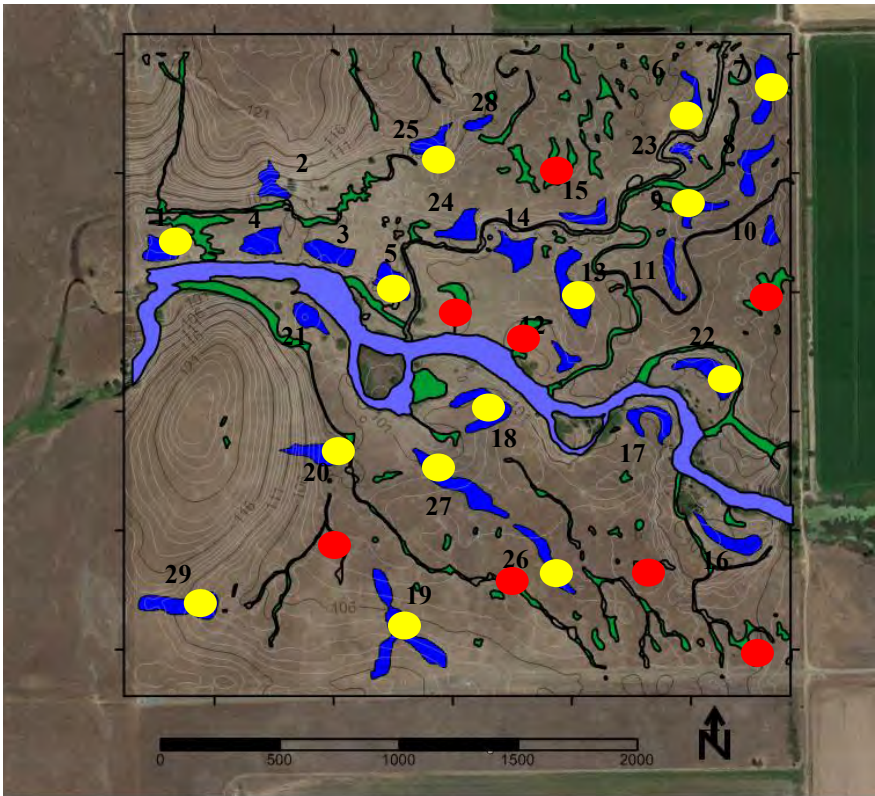





Figure 5.2 Proposed Monitoring of Created Vernal Pools and Reference Existing Natural Vernal Pools on the Shehadeh Property. Additional Reference Vernal Pools will be Monitored on the Adjacent Sacramento County Vernal Pool Preserve Property (see Figure 2.4)



Legend: Proposed created vernal  **Proposed Monitoring Created Vernal Pools** 
Onsite Reference Vernal Pools 

ATTACHMENT D

Site Evaluation, Hydrological Potential, and
Conceptual Onsite Seasonal and
Vernal Pool Wetland Creation Opportunities for the
Carson Creek Property

Site Evaluation, Hydrological Potential, and Conceptual Onsite Seasonal and Vernal Pool Wetland Creation Opportunities for the Carson Creek Property, Sacramento, California

Prepared for

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October 29, 2014

Summary

This report discusses the process of identifying potential locations for onsite seasonal wetland, swale, and vernal pool mitigation through creation. The approach for identifying potential wetland mitigation sites followed the US Army Corps of Engineers Guidelines for site evaluation based on a “watershed” approach and using hydrology and soils as primary factors in the assessment of wetland mitigation. This report provides baseline information of the physical features at the site to identify areas that are suitable based on hydrological and soil characteristics. Field measurements and analyses of existing, natural seasonal wetlands and vernal pools were used as a model for potential mitigation pools. Natural topography and soil features were specifically used to identify how mitigation seasonal wetlands could be created and experience hydrological functioning similar to existing natural seasonal wetlands. With additional field data, there is potential to create mitigation seasonal wetlands while not impacting the hydrology of the existing wetlands.

The report identified four areas covering 45 acres that have topographic and soil conditions suitable for the successful creation of seasonal wetlands and potentially vernal pools. Within these four areas it was estimated between 2.25 acres and 4.5 acres of seasonal wetlands potentially could be created. This is the maximum estimated acreage of seasonal wetlands and vernal pools that could be created without impacting existing wetlands. Additional study would define the actual acreage that could be created. The results are based on surveys of the surface topography and soil profiles. Those data were used to determine the landscape structure as a hydrological unit with local drainages that current discharge into Carson Creek. In addition, ground-penetrating radar surveys measured the density changes within the soil profiles of existing wetlands, channels, and vernal pools, as well as the uplands. This information was used to evaluate whether the soils have a water-restricting layers that could support a seasonal water table. A table lists the potential for creating seasonal wetlands including vernal pools onsite and identifies the potentials acres using a 5% and 10% wetland construction of the area. Additional information needs are identified to be able to develop a detailed seasonal wetland compensatory mitigation creation plan for the site.

Introduction

This report is a site evaluation and suitability for determining the feasibility of creating seasonal wetlands including vernal pools for the Carson Creek project property, Sacramento County, California (**Figure 1**). The purpose of this report is to identify potential opportunities for onsite wetland creation.

The approach of the study used the US Army Corps of Engineers' (USACOE) Mitigation and Monitoring Guidelines (December 30, 2004). Those guidelines state:

“The selection of a site with suitable hydrologic conditions has been one of the most neglected aspects of compensatory mitigation planning. The National Research Council’s *Compensating for Wetland Losses Under the Clean Water Act* (2001) stated that hydrological conditions, including variability in water levels and flow rates, are the primary driving force influencing wetland development, structure, functioning, and persistence.”

and

“Site selection should include and prioritize the following criteria:”

a. Natural Hydrology. The goal should be to have the aquatic feature be supported by a self-sustaining, natural hydrologic process requiring little or no long-term maintenance. It is recommended that the applicant compare hydrologic information at the compensatory mitigation site to similar reference (i.e., high-functioning) sites in the region, as well as to the impact site for design guidance.

c. Soil Characteristics. Many past compensatory mitigation projects did not address the development of suitable soils. Examination of soils at reference sites will provide important information on the target habitat. Thorough assessments of mitigation site soils should be conducted to determine the site’s suitability for supporting the target habitat. In the case of in-kind compensatory mitigation for wetlands, soils from the impacted aquatic habitat can be used at the compensatory mitigation site.”

Figure 1 Location of the Carson Creek Property



In addition, the objectives of this conceptual onsite vernal pool creation opportunities plan are to create additional vernal pool that:

- Do not directly or indirectly negatively impact any existing vernal pools, other wetlands, and rare and endangered plant or animal species,
- Utilizes the natural topography and soils and to mimic natural surface and subsurface water flow regimes resulting in vernal pool-swale complexes that in all respects mimic natural ones.

Methods

Background Information

Seasonal wetlands in the project area typically have a seasonal, near soil surface water table. The water table can be formed from shallow groundwater such as the hyporheic zone of an adjacent creek or a perched water table created by a water-restricting layer in the soil profile (Smith and Verrill 1998, Mitch and Gosselink 2000). Vernal pools are complex seasonal wetlands due to the structure of the soils and importance of the presence of soil depressions overlaying a shallow water-restricting layer (Hobson and Dahlgren 2001, Smith and Verrill 1998). The water-restricting layer, called a duripan for some specific types of soil horizons, is critical in the formation of a seasonal, perched water table (McCarten et al. 2009, Rains et al. 2006). The presence, depth, and topography of the water-restricting layer determine the hydrological functioning of individual vernal pools and their subsurface connectivity. The presence of the water-restricting layer is a requirement for soils when considering potential sites for vernal pool restoration or creation. Vernal pool wetlands are characterized by specific plants species (Barbour et al. 2007). Other seasonal wetlands may have relatively longer hydroperiods than vernal pools and be dominated by more common plant species found in a broader range of wetland habitats (Mitch and Gosselink 2000).

The project site is the Carson Creek project property (**Figure 1**). A jurisdictional wetlands delineation verified by the USACOE (ECORP 2014) was used to identify existing wetland resources on the site. Information on the soils mapped for the site was obtained from Natural Resources Conservation Service Online Soil Survey 2014 (<http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx>). Current and historic aerial photos were viewed on Google Earth Professional (Google Earth 2014).

Field Surveys

Field surveys using real time kinematic global positioning system (RTK GPS) and ground-penetrating radar (GPR) were conducted September 25, 27-29 and October 19, 2014.

Real Time Kinematic Global Positioning System

A Trimble R8 RTK GPS was used to survey the property in order to make high resolution (spatial precision of ± 1 cm, elevation ± 2 cm) topographic maps. This level of precision is needed to accurately measure relationships between vernal pool elevation gradients, soil horizons and surface and subsurface hydrology. The survey provides a baseline for the overall property upon which more detailed RTK GPS surveys can add to the existing data to develop a grading plan. The current survey included the full elevation range of the property.

Ground-Penetrating Radar

The GPR was used to conduct a non-destructive survey of the soil profile to evaluate the presence, continuity, and topography of soil horizons that form a water-restricting layer. A MALÅ Geosciences GPR system using an 800 MHz shielded antenna with a cart to measure distance was used to conduct the field surveys. The GPR transects ranged in length from about 200 feet to 1,000 feet. Transects focused on the low elevation gradient areas that had a higher feasibility for construction of wetlands.

The data collected were organized and analyzed in a step-wise process to understand the physical structure of the landscape that frames the hydrological unit in terms of the overall catchment structure, surface topography, and microshed subunit contributions. The components were characterized by maps showing physical relationships of the site that affect the hydrological processes. Existing wetland features were then overlain onto the landscape to understand the natural setting of wetlands, their connectivity, and drainage patterns.

Results

Figure 2 shows the Carson Creek property and the existing jurisdictional wetlands. **Figure 3** shows the study area overlain on a contour layer with one-foot contour intervals. The elevations range from about 116 feet above mean sea level (msl), within Carson Creek channel, to approximately 160 feet msl on the top of the east side hills.

Figure 2 Map of the Carson Creek Property Showing Existing Jurisdictional Wetlands

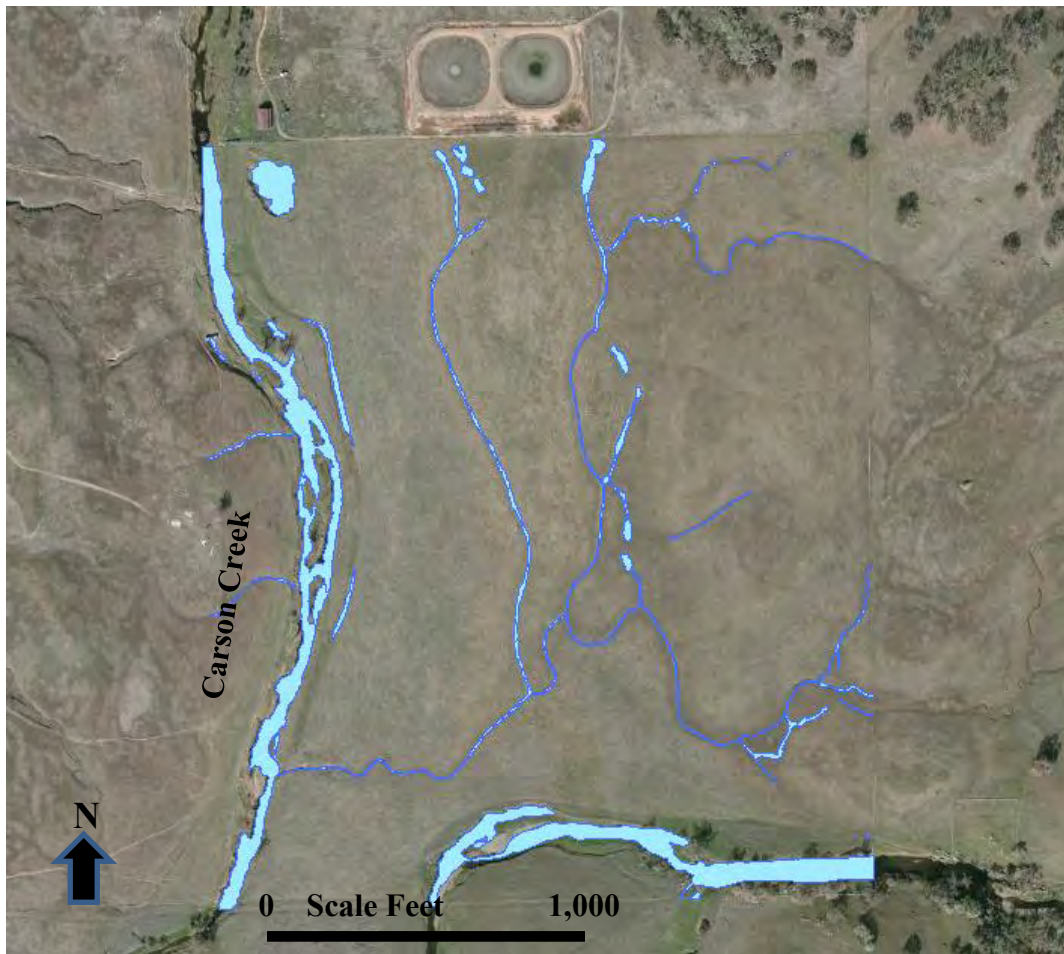


Figure 3 Carson Creek Showing Existing Wetlands Overlain on One-foot Elevation Contours Ranging from 116 feet (msl) to 160 feet (msl).

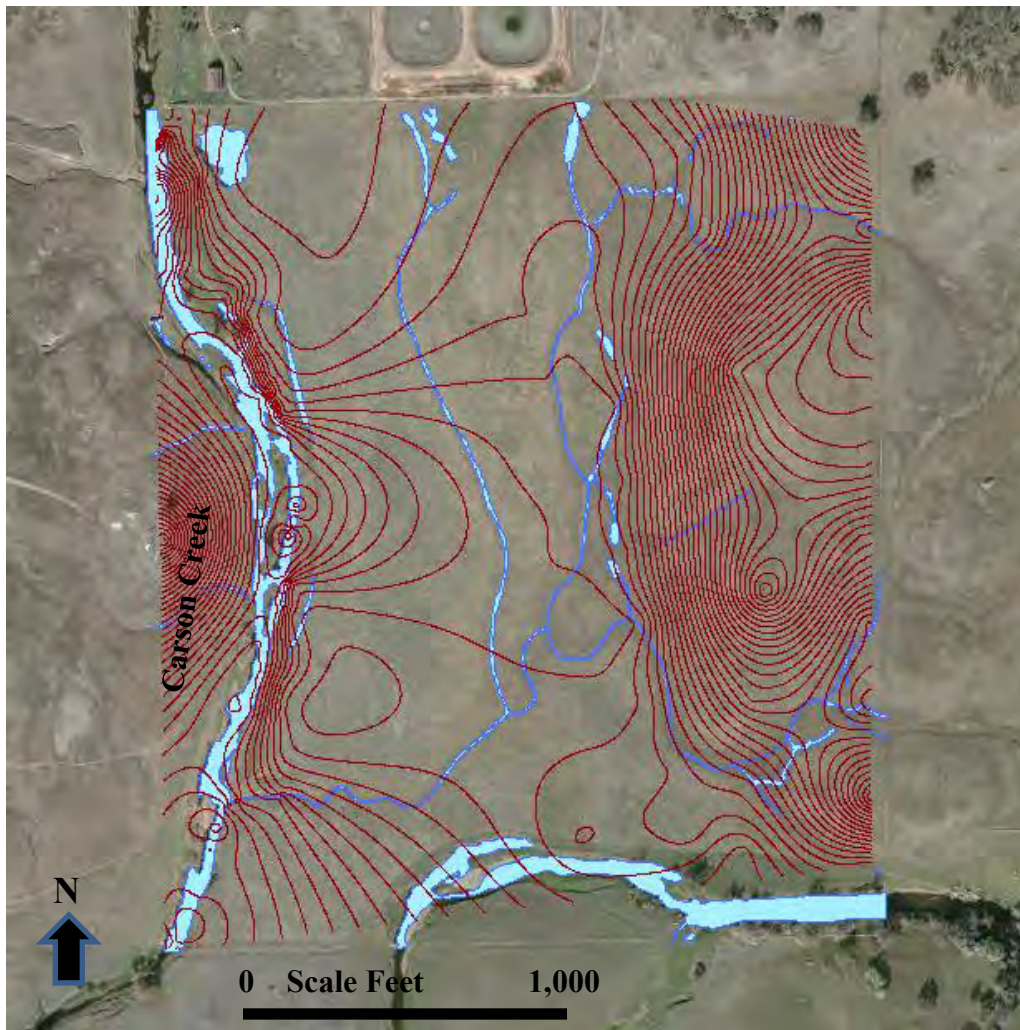


Figure 4 is a direction of flow map with arrows indicating the direction of gravitational water flow. Although the site has a relatively low gradient on the main terrace, not all flows are in the direction of Carson Creek. The internal drainages on the main terrace have distinct areas of upland water discharge into them. However, these ultimately drain into Carson Creek. The east side slope is the steepest gradient covering about twenty percent of the property. It would supply considerable discharge into the terrace drainages and provide some seasonal storage of water.

Figure 4 Vector Flow Map of Carson Creek Site

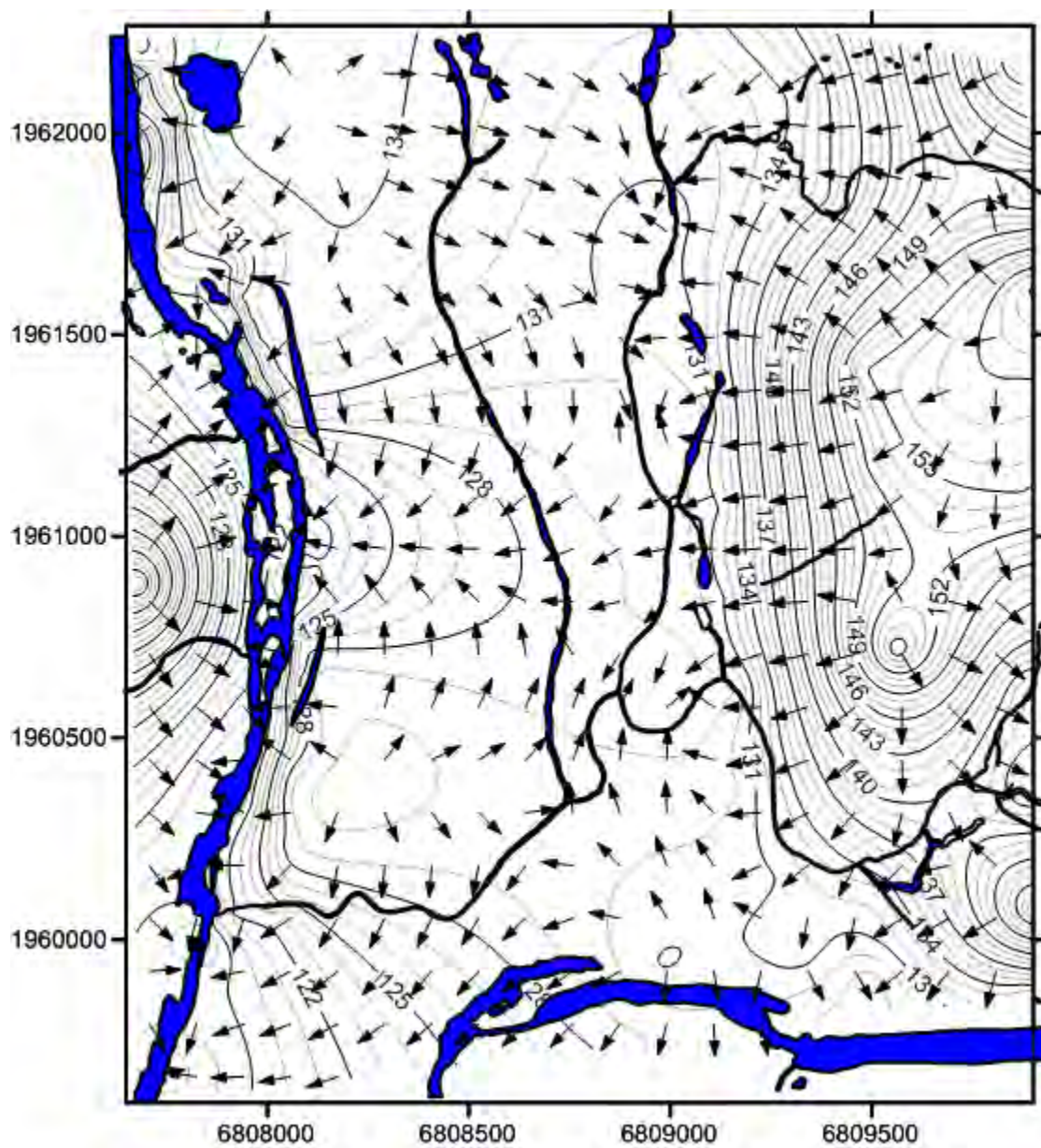
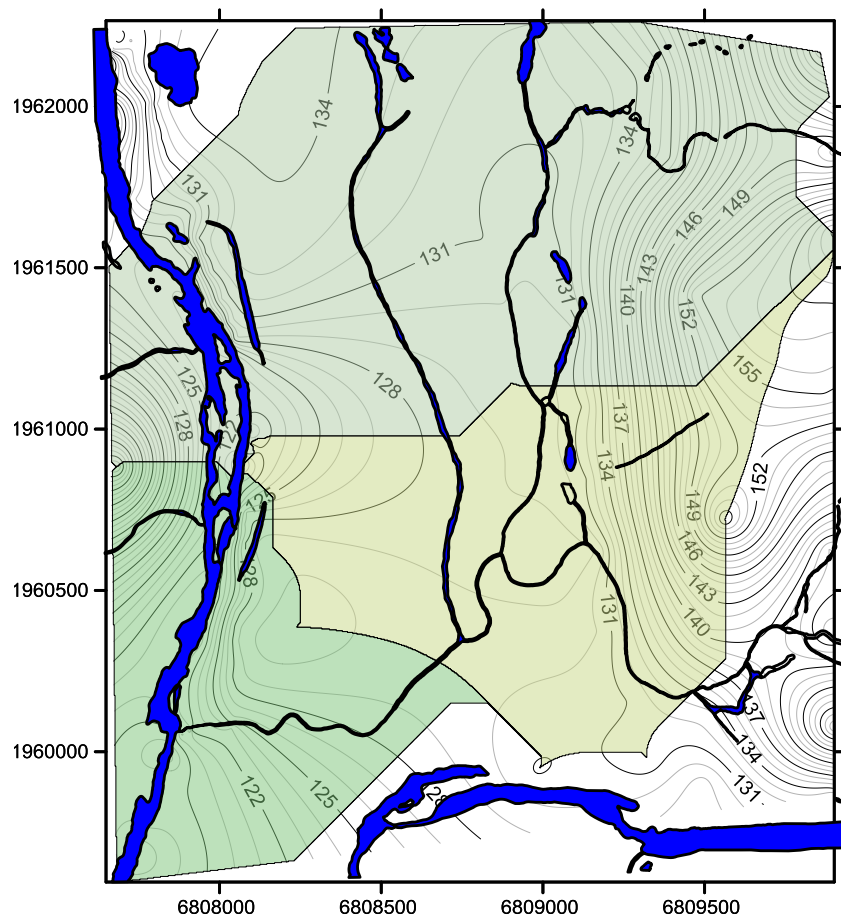


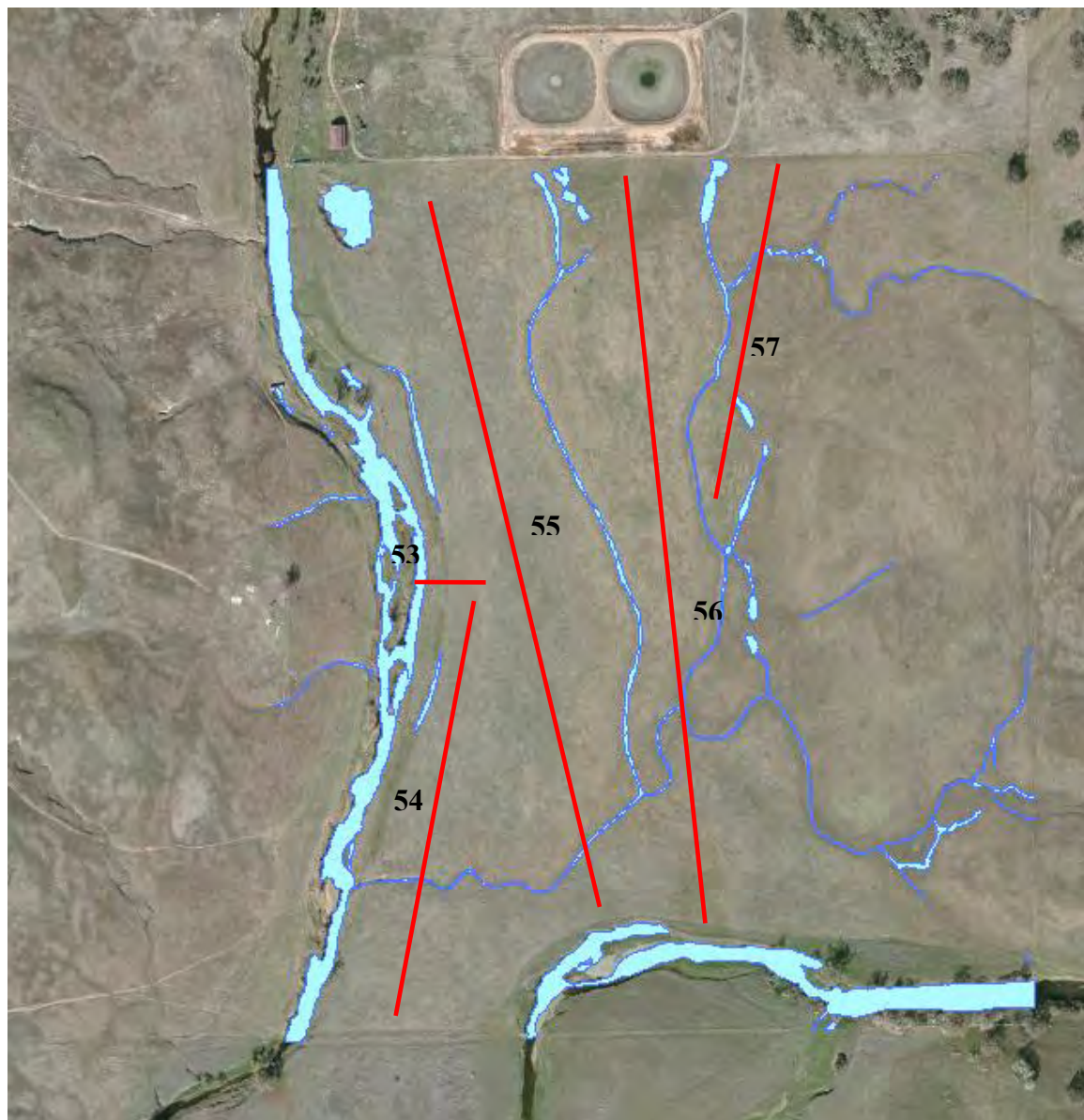
Figure 5 represents the microshed polygons within the property that are at a scale that show the correlation of vernal pool and swale complexes and drainages with the landscape topography.

Figure 5 Carson Creek with Existing Wetlands and Catchment Drainage Area Polygons



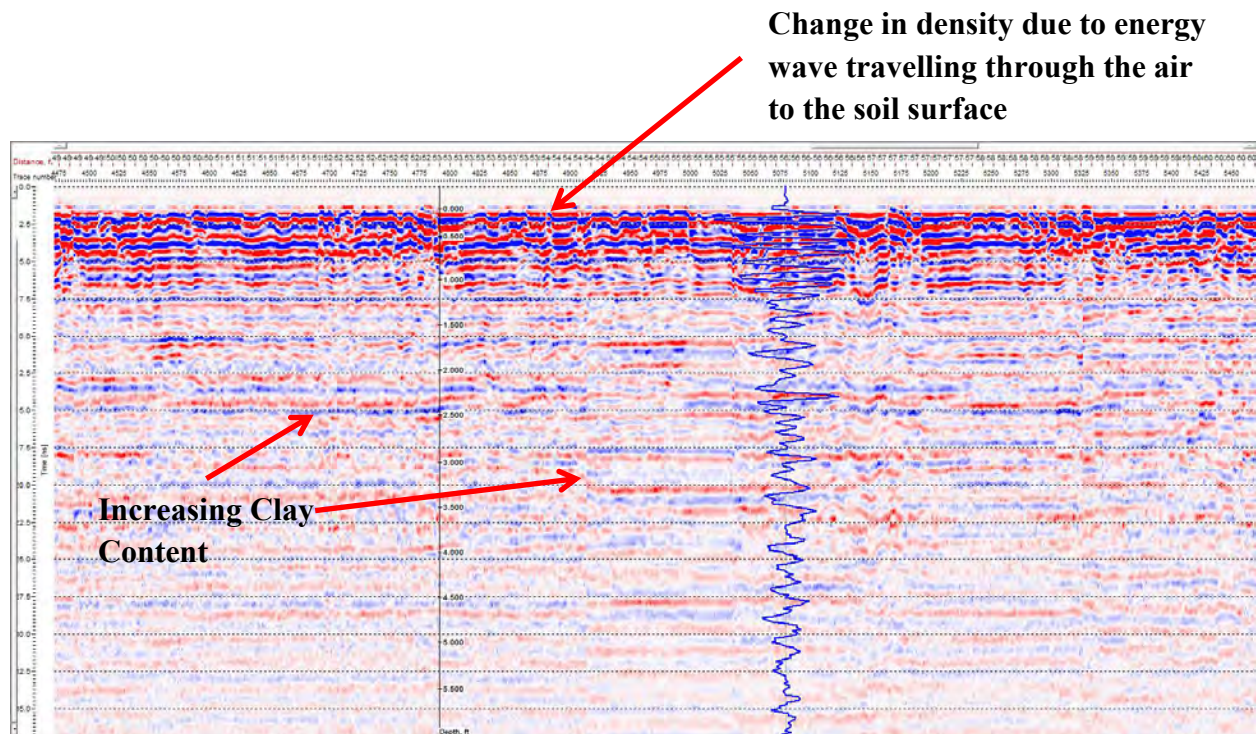
A total of thirteen GPR transects were made on the site and five are represented in this report (**Figure 6**). **Appendix A** includes five representative GPR transect profiles mapped in **Figure 6**.

Figure 6 Map of Transects from the GPR Survey.



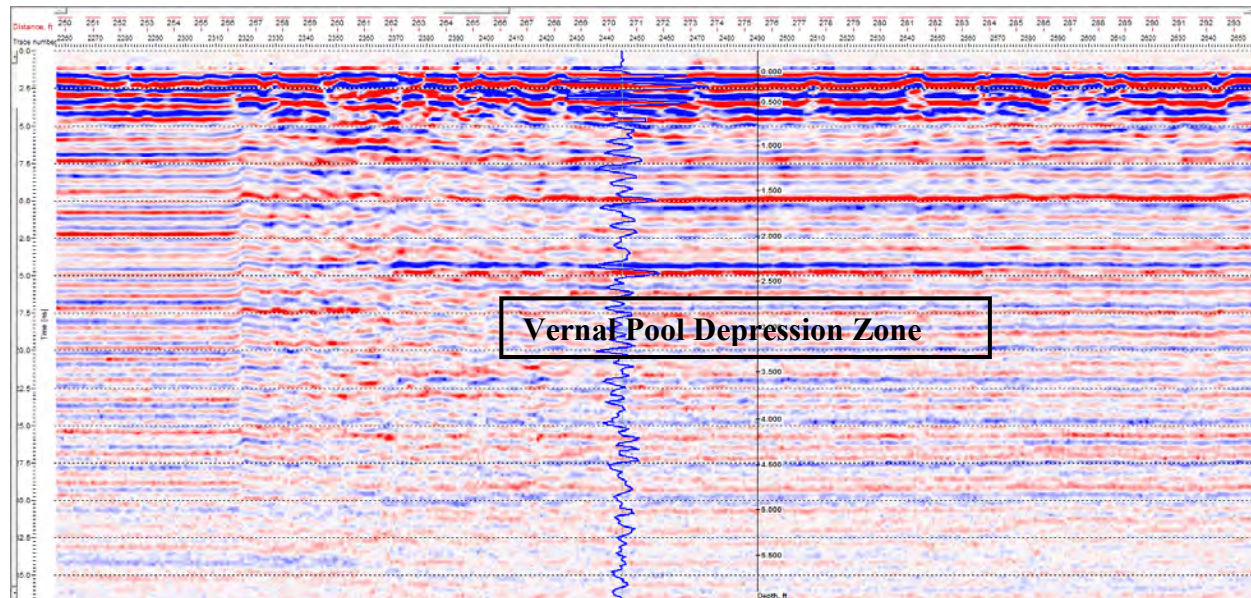
The GPR transect profiles shown here are representative of the overall landscape soil profiles. The red and blue lines represent the positive and negative parts of the energy wave as it is reflected back to the GPR antenna. Changes in density of the soil will result in a change in the intensity of the color of the red and blue signatures. Natural vernal pool and swale systems were surveyed to identify the range of depth of water-restricting layers beneath a vernal pool depression as well as the depth in the surrounding uplands. **Figure 7** shows GPR transect 1 which crosses a typical part of the landscape. An increasing amount of clay is also observable from the GPR wave density signatures within the upper 2 to 4 feet.

Figure 7 Transect 55 distance 108 feet, showing clay zones within the soil profile of Hicksville Soil



Examples of vernal pools on the Carson Creek site are uncommon and are associated with soils that differ from those on most of the site. **Figure 8** represents a GPR transect across a vernal pool at the toe of the eastern slope with distinct clay layers in the soil profile 1.5 to 2.5 feet. The depth to a potential water-restricting layer in the soil profile was between one to a half a feet below the soil surface. The depth of the water-restricting layer in the uplands, when present, was within two to three feet.

Figure 8 Transect 57A Distance of 78 feet includes crossing of Vernal Pool



The GPR data identified the presence, continuity, and depth variation of clay layers in the soil profiles. None of the GPR data indicated the presence of a duripan. The GPR data are consistent with the mapped soil series from the NRCS Web Soil Survey (**Figure 9**). The two main soil series, Hicksville loam and Corning, represent over seventy seven percent of the area (**Table 1**). The Corning soil series (**Appendix B**) is known to support vernal pools (Smith and Verrill 1998). The NRCS Hicksville loam description indicates an increase in clay content with depth and the likelihood of forming a seasonal shallow water table (**Appendix B**).

Figure 9 NRCS Web Soil Survey Map for Cordova Hills Property.



Table 1 NRCS List Soil Series Map Information of Soil Units in Figure 9.

Carson Creek Property, Sacramento County, California			
Map Unit Symbol	Map Unit Name	Acres in Area	Percent of Area
101	Amador-Gillender complex, 2 to 15 percent slopes	10.9	6.1%
109	Auburn silt loam, 2 to 30 percent slopes	1.5	0.9%
125	Corning complex, 0 to 8 percent slopes	54.8	30.8%
132	Creviscreek sandy loam, 0 to 3 percent slopes	8.6	4.8%
158	Hicksville loam, 0 to 2 percent slopes, occasionally flooded	81.9	46.0%
242	Xerofluvents, 0 to 2 percent slopes, flooded	20.3	11.4%
Totals for Area of Interest		178.0	100.0%

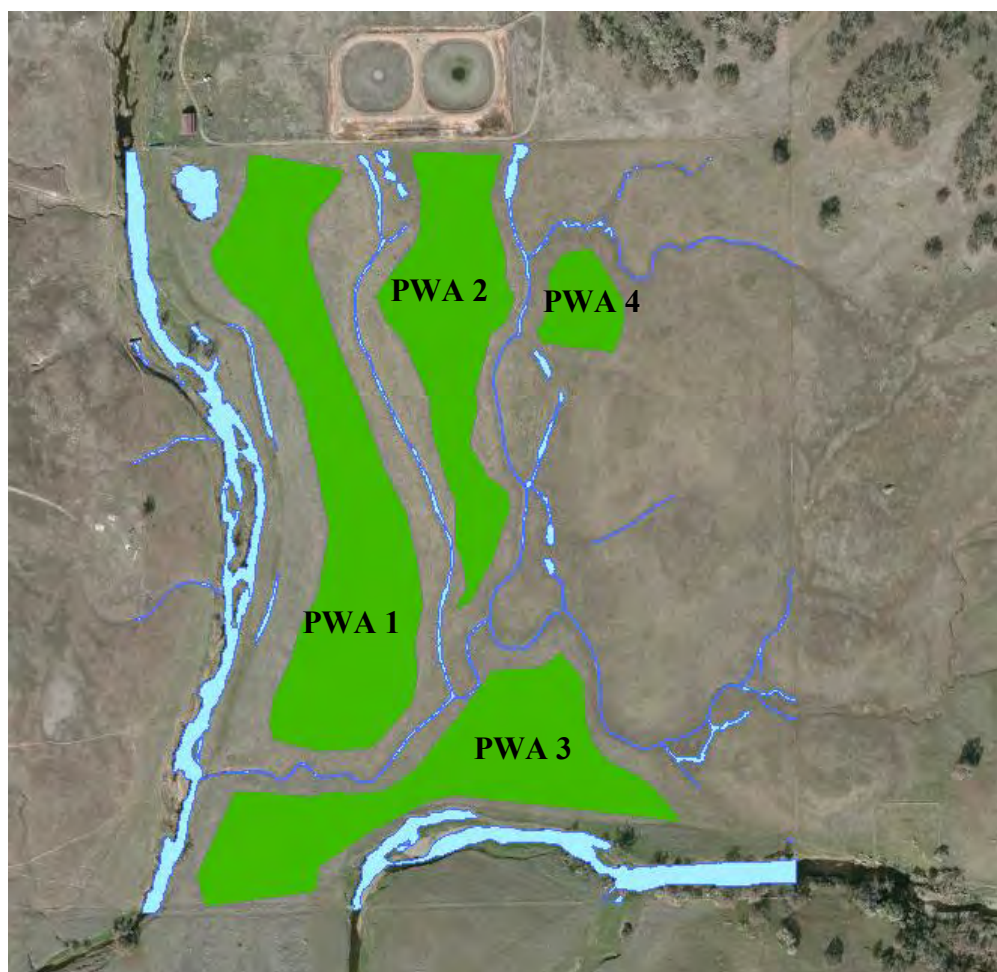
Discussion

The data analysis for the project site determined there are some areas, with further study, that could be used for creating seasonal wetlands and in one area vernal pool wetlands. Four areas were identified have a low elevation gradient with relatively large areas of upland and the soils have a duripan or clay water-restricting layer within the upper two and half feet (**Figure 10**). **Table 2** identifies each Potential Wetland Area, the approximate acres, reference GPR transect (**Appendix A**), potential and constraints and potential acres of creation based on a 5% and 10% of area scenarios. These scenarios are given to estimate a maximum level of 10% because this is the higher end of natural vernal pool densities in Sacramento County and half that value allows for inclusion of existing wetlands within the local catchment area. The potential is based on the soil type and depth to water-restricting layer as determined by GPR. No specific constraints are known at this time.

Table 2 Potential Wetland Areas for Construction

Potential Wetland Area	GPR Transect(s)	Potential & Constraints	Potential Acres (5% of Area)	Potential Acres (10% of Area)
Potential Wetland Area 1 (20 acres)	53, 54, 55	High potential for shallow water table during winter and spring creek runoff	1	2
Potential Wetland Area 2 (9 acres)	56	High potential for shallow water table during winter and spring creek runoff	0.45	0.9
Potential Wetland Area 3 (14 acres)	54, 55, 56	High potential for shallow water table during winter and spring creek runoff	0.7	1.4
Potential Wetland Area 4 (2 acres)	57	Medium to high potential depending on catchment winter/spring runoff	0.1	0.2
Total Acres 45			2.25	4.5

Figure 10 Areas of Potential Wetland Creation



Next Steps

Most of the Potential Wetland Areas have a high suitability as seasonal wetland creation sites. Only Potential Wetland Area 4 has soils that are suitable for vernal pool creation. Additional more detailed RTK GPS and GPR surveys are needed to focus within those areas that are considered feasible at this point in time. Additional RTK GPS data will provide more details of the surface elevations that are important for determining the direction of water flow and area of upland water contribution. Additional GPR surveys will determine if the presence and depth of the clay water-restricting layers observed in this study are continuous at the depths measured. With the additional information the location, size, shape and depth of constructed wetland depressions can be mapped with higher certainty and knowledge of how they will function hydrologically. These data could be used to create the grading plan and simplify the grading implementation and remove guess work from the field implementation and construction. Finally, for each created wetland a water balance will be calculated to predict the hydroperiod (inundation period) using dry, average, and wet rainfall years prior to construction. Adjustments to pool construction design such as adjusting the depth to water-restricting layers can allow for greater diversity in hydrological functioning.

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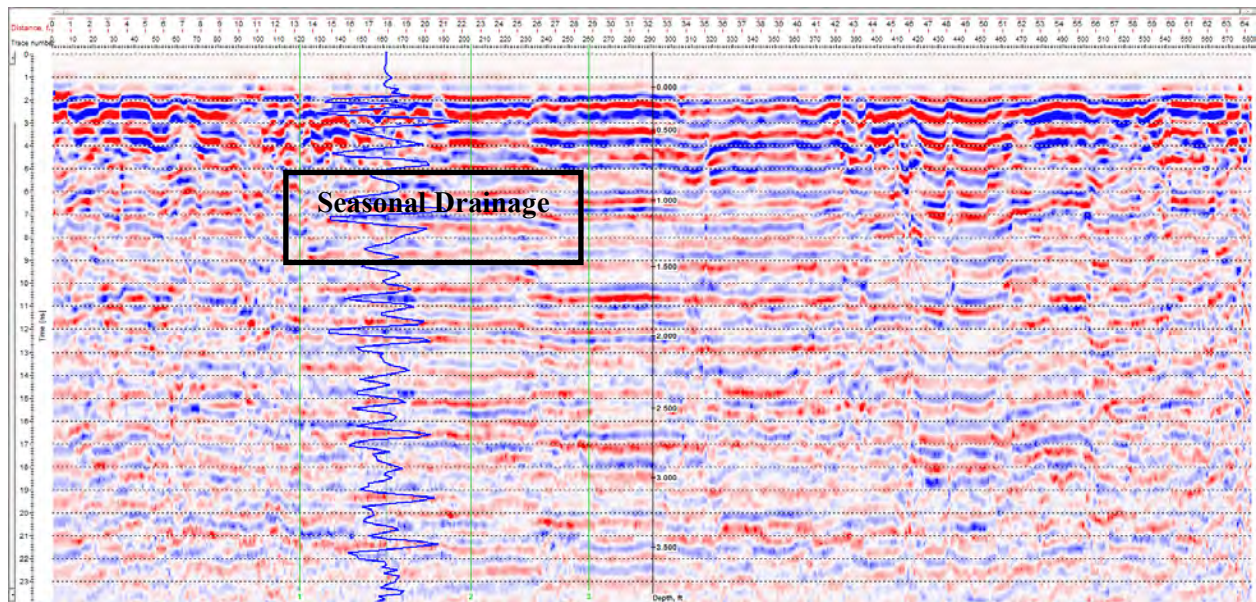
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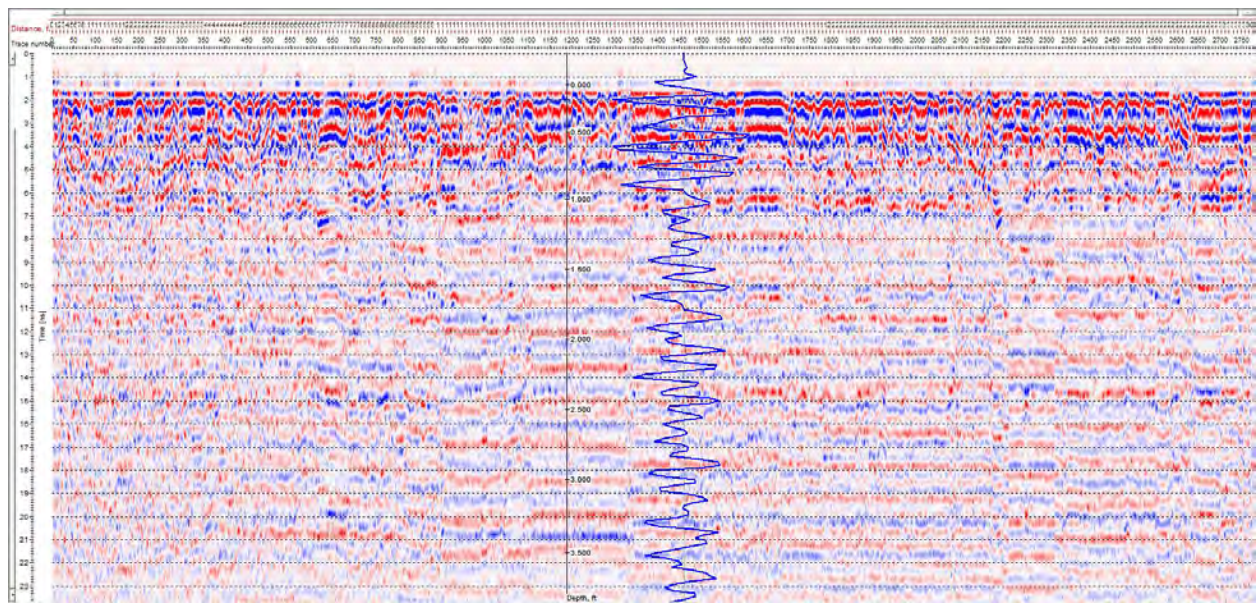
APPENDIX A

Ground-Penetrating Radar Transects

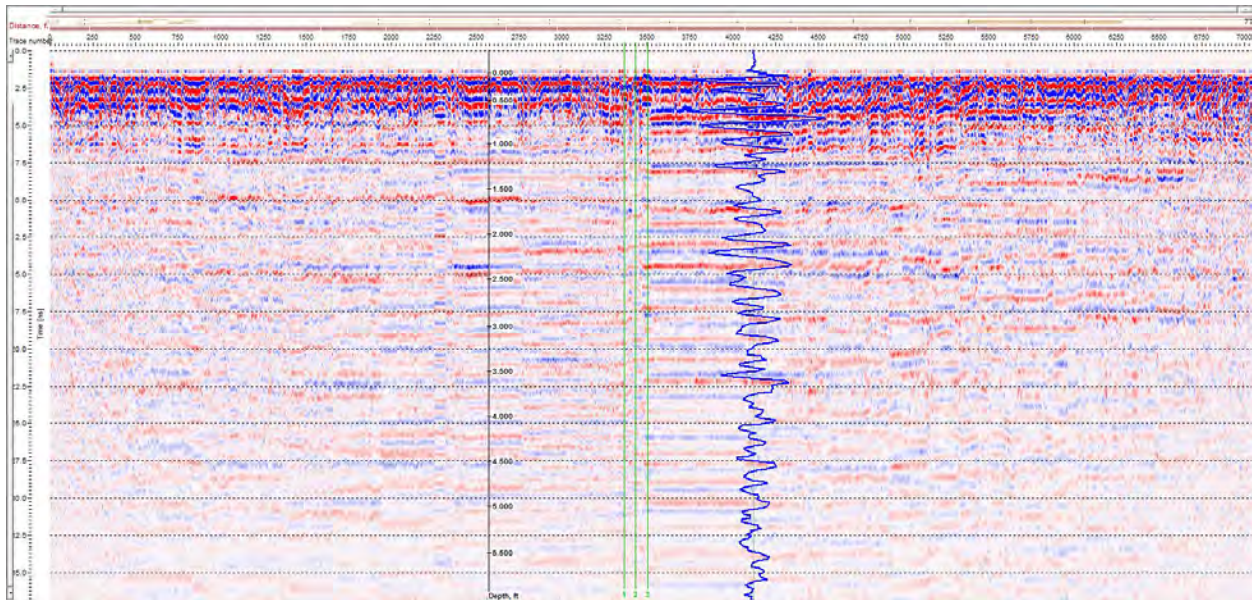
Transect 53 distance 64 feet with crossing of seasonal drainage



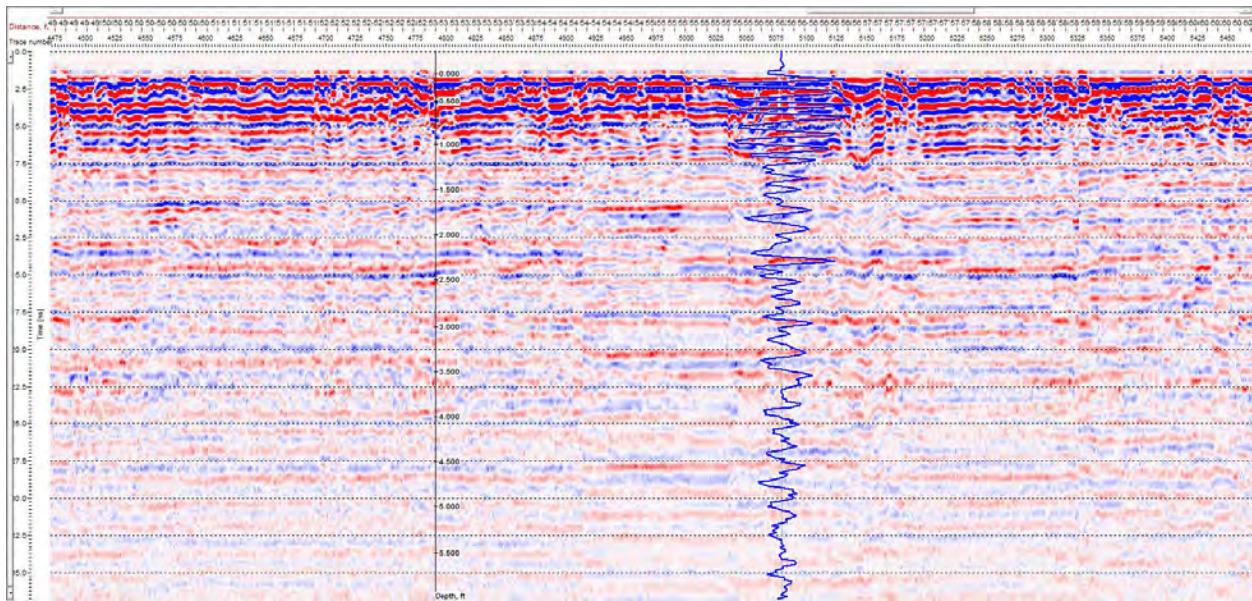
Transect 54 distance 307 feet



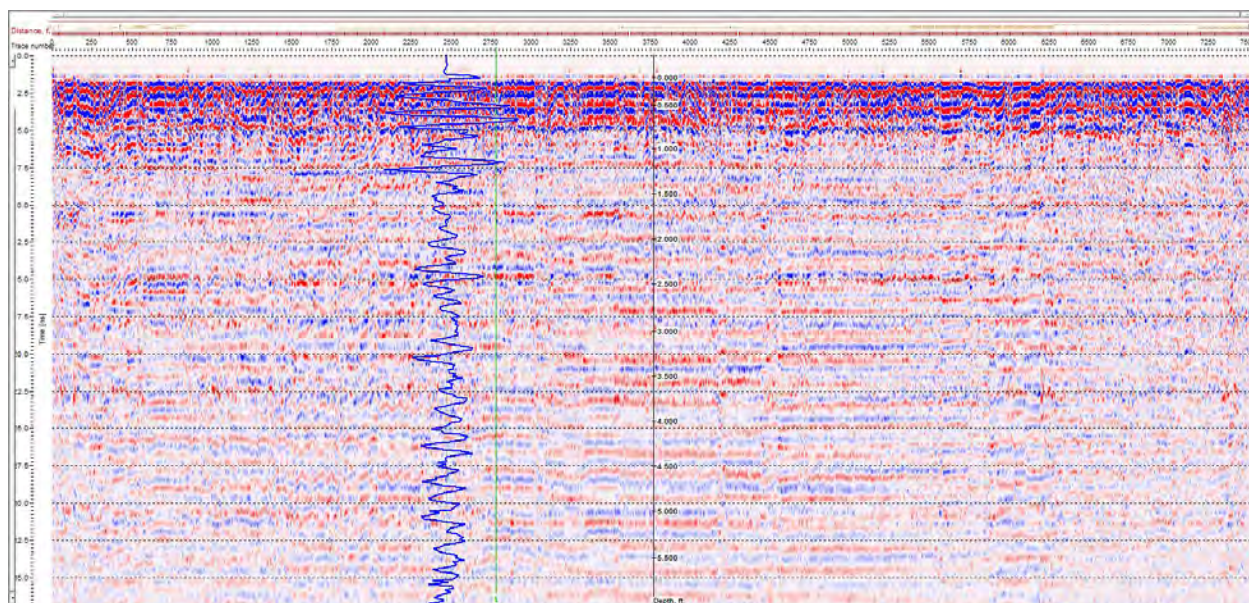
Transect 55 distance 779 feet



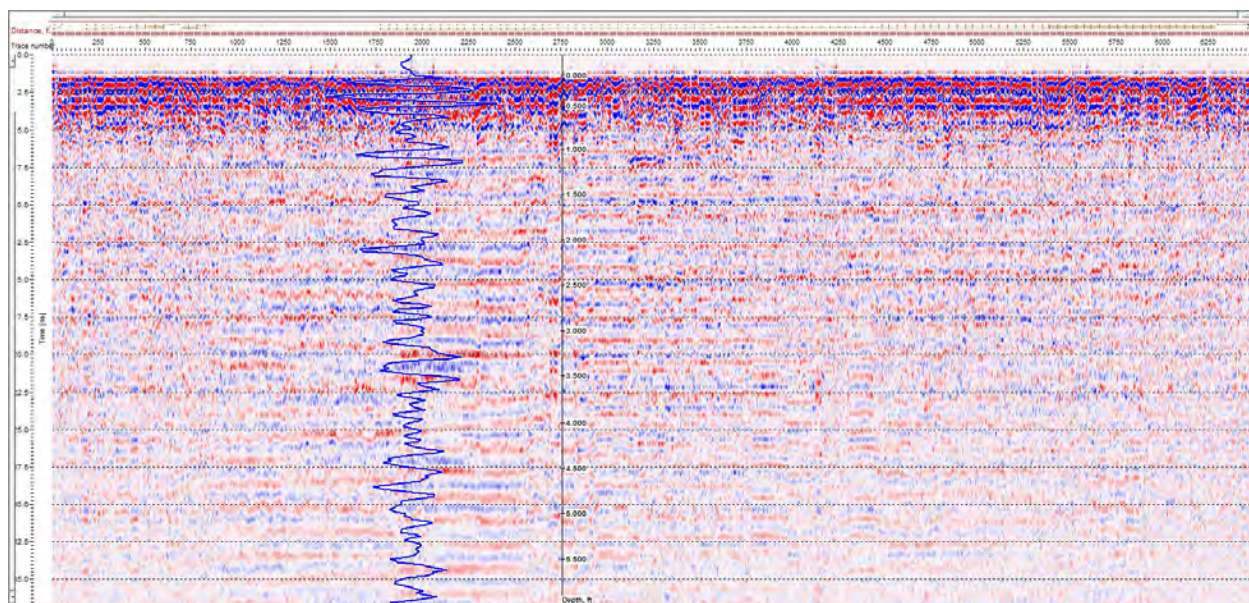
Transect 55B distance 108 feet, showing clay zones within the soil profile of Hicksville Soil



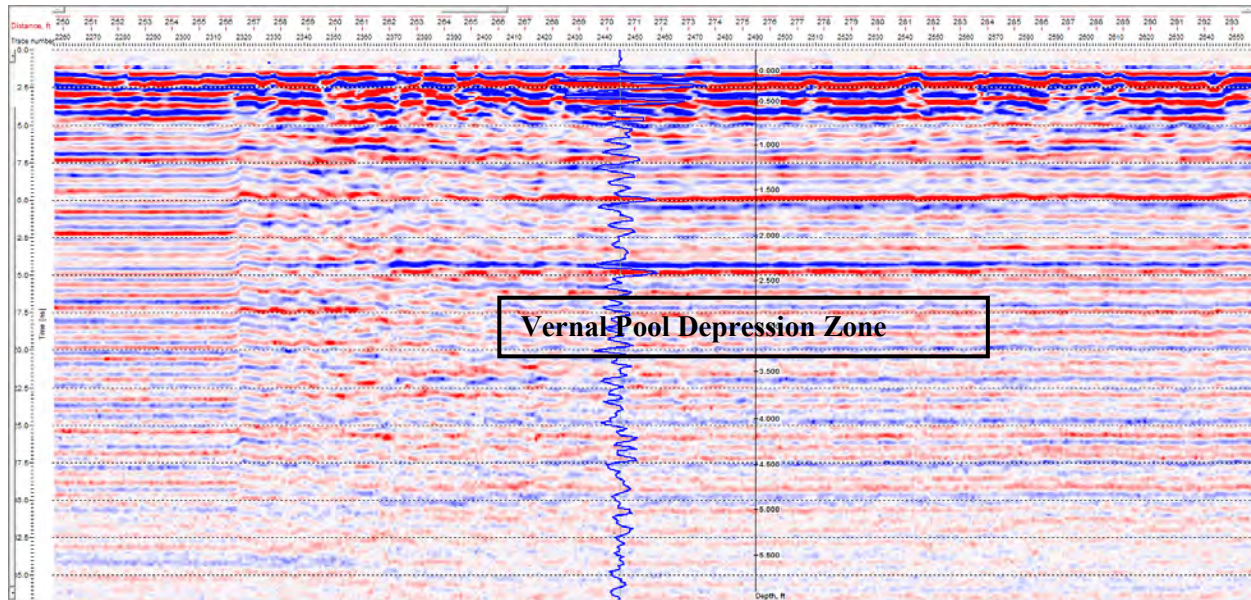
Transect 56 distance 832 feet



Transect 57 Distance 715 feet



Transect 57A Distance of 78 feet includes crossing of Vernal Pool



APPENDIX B

NRCS Soil Series Description for Hicksville and Corning Series

LOCATION HICKSVILLE

CA

Established Series

Rev. JMW-AJT-MAM-CEJ

01/2003

HICKSVILLE SERIES

The Hicksville series consists of deep and very deep, moderately well drained soils that formed in alluvium derived from mixed rock sources. Hicksville soils are on low stream terraces and alluvial flats along drainageways of terraces and hills. Slopes are 0 to 5 percent. The mean annual precipitation is about 17 inches and the mean annual temperature is about 60 degrees F.

TAXONOMIC CLASS: Fine-loamy, mixed, superactive, thermic Mollic Haploxeralfs

TYPICAL PEDON: Hicksville loam - on a smooth, east facing slope of less than 1 percent under annual grasses and forbs at an elevation of 80 feet. When described March 22, 1977, the soil was slightly moist throughout. (Colors are for dry soil unless otherwise stated.)

A--0 to 5 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; massive; hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine interstitial and few very fine tubular pores; moderately acid (pH 6.0); clear smooth boundary. (4 to 9 inches thick)

AB--5 to 13 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; common very fine interstitial and few very fine tubular pores; slightly acid (pH 6.3); clear smooth boundary. (0 to 12 inches thick)

Bt1--13 to 18 inches; brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few very fine roots, common very fine interstitial and tubular pores; few thin colloid stains bridging mineral grains; slightly acid (pH 6.5); clear smooth boundary.

Bt2--18 to 31 inches; brown (7.5YR 5/4) clay loam, dark brown (10YR 4/3) moist; few light gray (10YR 7/1) dry bleached sand grains on ped faces; moderate medium and coarse subangular blocky structure; very hard, firm, sticky and plastic; few very fine roots; common very fine interstitial and few very fine tubular pores; common moderately thick clay films on ped faces and lining pores; neutral (pH 7.0); gradual smooth boundary.

Bt3--31 to 43 inches; brown (7.5YR 5/4) sandy clay loam, dark brown (10YR 4/3) moist; common light gray (10YR 7/1) dry bleached sand grains on ped faces; moderate medium and coarse subangular blocky structure; very hard, firm, sticky and plastic; few very fine interstitial and tubular pores; many moderately thick clay films on ped faces and lining pores; slightly alkaline (pH 7.5); gradual wavy boundary. (combined thickness of the Bt horizons is 16 to 35 inches)

BCt--43 to 65 inches; pale brown (10YR 6/3) sandy clay loam, dark yellowish brown (10YR 4/4) moist; moderate coarse subangular blocky structure; very hard, firm, sticky and plastic; few very fine

interstitial and tubular pores; many moderately thick strong brown (7.5YR 4/6) clay films on ped faces, lining pores and bridging mineral grains; dark yellowish brown (10YR 4/4) moist; slightly alkaline (pH 7.8).

TYPE LOCATION: Sacramento County, California; about 1.3 miles northeast of Herald, 700 feet north and 800 feet west of the southeast corner of sec. 5, T. 5 N., R. 7 E.

RANGE IN CHARACTERISTICS: Solum thickness ranges from 25 to 60 inches or more. The mean annual soil temperature is 64 to 67 degrees F and the temperature remains above 47 degrees F throughout the year. The soil is dry between 6 and 18 inches in most years from June 1 to October 15, moist in all parts from December 1 to May 1 and moist in some part the rest of the year. Weighted average clay content of the upper 20 inches of the argillic horizon is 27 to 35 percent.

The A horizon is 10YR 4/3, 5/2 or 5/3. Moist color is 10YR 3/2, 3/3; or 7.5YR 3/2. Texture is loam, gravelly loam or sandy clay loam with 18 to 27 percent clay. Content of gravel is 0 to 35 percent. Organic matter is 1 to 3 percent in the upper 4 inches. Some subhorizons are massive and hard or organic matter content decreases with depth to less than 1 percent at 9 inches. Reaction is moderately acid or slightly acid.

Some pedons have an AB horizon. Color and reaction are similar to the A horizon. Content of clay is 1 to 4 percent greater than the A horizon.

The Bt horizon is 10YR 4/3, 5/2, 5/3, 5/4, 6/3, 6/4; 7.5YR 4/4, 5/4 or 6/4. Moist color is 10YR 3/2, 3/3, 4/3, 4/4; or 7.5YR 4/4, 3/4. Bleached sand grains with dry color of 10YR 7/1, 7/2, or 6/5 occur on ped faces of lower subhorizons. Texture is sandy clay loam or clay loam with 27 to 35 percent clay. Content of gravel is 5 to 35 percent. Reaction is slightly acid to slightly alkaline. Base saturation (SUM) is 75 to 100 percent.

The BCt and 2Bt horizon is 10YR 5/3, 5/4, 6/3, 6/4 or 7.5YR 5/4. Moist color is 10YR 4/3, 4/4; 7.5YR 4/4. Bleached sand grains with dry color of 10YR 6/3, 7/1 or 7/2 occur on ped faces. Texture is sandy loam or sandy clay loam with 15 to 25 percent clay. Content of gravel is 5 to 15 percent. Reaction is slightly acid to slightly alkaline.

A 2Bt horizon is present in most pedons that have gravelly textures throughout. It is 5Y 6/2, 6/3; 2.5Y 6/2; or 10YR 6/3, 6/4 or 7.5YR 5/4. Moist color is 2.5Y 5/4, 6/3; 10YR 5/2, 5/3, 6/3 or 7.5YR 4/4. Coarse textured layers have bleached sand grains with dry color of 10YR 6/3, 7/1, 7/2. Texture is stratified loamy sand to clay loam. Content of coarse fragments averages 35 to 60 percent but is 0 to 35 percent in some subhorizons. Content of cobbles is 0 to 5 percent. Reaction is neutral to slightly alkaline.

COMPETING SERIES: These are the [Academy](#) (T), Bellysprings (T), [Burchell](#), [Cajalco](#) (T), [Coarsegold](#), [Honn](#) (T), [Jacinto](#), [Modesto](#), [Olashes](#), [Perkins](#), [Pinspring](#) (T), [Pleasanton](#), [Rescue](#), [Sobrante](#), [Sodabay](#), [Trimmer](#) and [Whitney](#) series. Coarsegold, Trimmer and Whitney soils have a paralithic contact at a depth of 20 to 40 inches. Burchell soils have a moderately or strongly alkaline argillic horizon. Jacinto and Pleasanton soils have 18 to 27 percent clay in the control section. Modesto soils have slowly permeable dense Bt horizons. Olashes soils lack bleached sand grains in the Bt horizon. Perkins and Rescue soils have a Bt horizon with hues of 5YR and 2.5YR. Sobrante soils have a lithic contact at a depth of 20 to 40 inches. Sodabay soils have 5YR hues throughout and are predominantly amorphous.

GEOGRAPHIC SETTING: Hicksville soils are on low stream terraces and on alluvial flats along drainageways of terraces and hills at elevations of 30 to 230 feet. Slopes are 0 to 5 percent. The soils formed in alluvium from mixed rock sources. The underlying consolidated sediments are also from mixed rock sources. The climate is subhumid with hot, dry summers and cool, moist winters. Mean annual precipitation is 16 to 22 inches. Mean annual temperature is about 60 to 61 degrees F; average January temperature is about 44 degrees F; and average July temperature is about 77 degrees F. Frost-free period is 250 to 300 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the [Columbia](#), [Corning](#), [Hadselville](#), [Redding](#), [San Joaquin](#) and [Pentz](#) soils. Columbia soils have a coarse-loamy textural control section and are on low flood plains. Corning soils have a fine textured control section and are on high terraces. Hadselville soils are very shallow, have a mollic epipedon and are on hills. Redding and San Joaquin soils have a duripan at a depth of 20 to 40 inches and are on high terraces and low terraces respectively. Pentz soils are shallow, have a mollic epipedon and are on hills.

DRAINAGE AND PERMEABILITY: Moderately well drained; very slow to slow runoff; moderately slow permeability. The soils are flooded occasionally for very brief periods during high intensity storms in December through April. A water table occurs in very deep pedons at depths of 60 to 72 inches for short periods in December through April. A perched water table occurs in deep pedons at a depth of 36 to 48 inches for short periods in December through April.

USE AND VEGETATION: These soils are used for livestock grazing. A few areas are used for irrigated hay and pasture and irrigated row and orchard crops. Vegetation is soft chess, wild oats, rigput brome, needlegrass and filaree.

DISTRIBUTION AND EXTENT: Low stream terraces and alluvial flats along creeks and minor drainageways of the eastern part of the Sacramento and San Joaquin Valley. These soils are not extensive in MLRA-17.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Davis, California

SERIES ESTABLISHED: Sacramento County, California, 1985.

REMARKS: These soils were formerly mapped as the Bear Creek series in the Sacramento Area, California, 1954 Soil Survey Report.

The activity class was added to the classification in January of 2003. Competing series were not checked at that time. - ET

Diagnostic horizons and features recognized in this pedon are:

Ochric epipedon - the zone from the surface to 13 inches (A, AB)

Argillic horizon - the zone from 13 to 43 inches (Bt1, Bt2, Bt3)

National Cooperative Soil Survey
U.S.A.

LOCATION CORNING

CA

Established Series

Rev. SBJ/AJT/DJE/MAV/SBS/WRR

01/2001

CORNING SERIES

The Corning series consists of very deep, well or moderately well drained soils formed in gravelly alluvium weathered from mixed rock sources. Corning soils are on high terraces with mound, intermound microrelief. Slopes are 0 to 30 percent. The mean annual precipitation is about 23 inches and the mean annual temperature is about 62 degrees F.

TAXONOMIC CLASS: Fine, mixed, active, thermic Typic Palexeralfs

TYPICAL PEDON: Corning gravelly loam - on a 2 percent slope under annual grasses and forbs at an elevation of 270 feet. When described April 5, 1945, the soil was moist throughout. (Colors are for dry soil unless otherwise stated.)

Ap--0 to 8 inches; yellowish red (5YR 5/6) gravelly loam, yellowish red (5YR 4/6) moist; weak fine granular structure; hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine pores; strongly acid (pH 5.5); gradual smooth boundary. (4 to 9 inches thick)

A1--8 to 15 inches; yellowish red (5YR 5/6) gravelly loam, dark red (2.5YR 4/6) moist; weak fine and medium angular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine pores; moderately acid (pH 5.8); abrupt smooth boundary. (5 to 10 inches thick)

A2--15 to 21 inches; yellowish red (5YR 5/6) gravelly loam, dark red (2.5YR 4/6) moist; weak fine and medium angular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine pores; strongly acid (pH 5.4); abrupt wavy boundary. (5 to 8 inches thick)

Bt1--21 to 29 inches; red (2.5YR 5/6) gravelly clay, dark red (2.5YR 4/6) moist; strong coarse angular blocky structure that separates readily to very fine subangular blocky on drying; extremely hard, extremely firm, sticky and very plastic; few very fine roots; common very fine tubular pores; continuous moderately thick clay films on faces of peds and lining pores but most are as bridges; strongly acid (pH 5.2); clear wavy boundary. (5 to 15 inches thick)

Bt2--29 to 36 inches; yellowish red (5YR 5/6) gravelly clay loam, dark red (2.5YR 4/6) moist; weak coarse angular blocky structure; very hard, very firm, sticky and plastic; few very fine roots; common very fine pores; continuous moderately thick clay films lining pores and on a few faces of peds, strongly acid (pH 5.2); clear wavy boundary. (4 to 10 inches thick)

C--36 to 60 inches; yellowish red (5YR 5/6) gravelly stratified sandy clay loam, red (2.5YR 4/6) moist; massive; hard, firm, slightly sticky and plastic; few very fine roots; common very fine pores; continuous thin clay films lining pores, moderately thick along cleavage planes; strongly acid (pH 5.2); diffuse smooth boundary.

TYPE LOCATION: Tehama County, California; about 3 miles south of Corning and 0.6 mile north of the SW corner of section 22, T.23 N., R.3W., just east of old US Highway 99W.

RANGE IN CHARACTERISTICS: Solum thickness is 23 to 60 inches. Soil temperature is greater than 47 degrees F throughout the year. Mean annual soil temperature is 60 to 67 degrees F at 20 inches. Solum thickness differs over short distances because of hummocky microrelief.

The soil between depths of 7 and 20 inches is usually moist in some part from about late October until late May and is continuously dry the rest of the time. Weighted average clay content of the upper 20 inches of the argillic horizon is 35 to 55 percent.

The A horizon is 7.5YR 4/4, 4/6, 5/4, 5/6, 6/4, 6/6; 5YR 3/4, 4/4, 4/6, 5/3, 5/4, 5/6, 6/3, 6/4, 6/6; 2.5YR 4/6, 5/4, 5/6, 6/4, 6/6, 10YR 5/6, 5/4, and 5/3. Moist color is 10YR 4/4, 3/4, and 3/3 and 7.5YR 4/4, 3/3, 3/4; 5YR 3/4, 3/6, 4/4, 4/6; 2.5YR 3/4, 3/6, 4/4. In the concave intermound, the upper 2 to 9 inches of the A horizon has dry color of 10YR 5/3, 5/4, 5/6, 6/3, 6/4; 7.5YR 5/4, 4/4 and moist color is 10YR 3/3, 4/3, 3/4, 4/4; 7.5YR 3/4, 4/4. Texture is clay loam, sandy clay loam, loam, sandy loam or fine sandy loam or their gravelly or cobbly equivalents. Content of coarse fragments is 0 to 35 percent. In some pedons organic matter content is greater than 1 percent in the upper 1 to 3 inches but in all pedons it decreases to less than 1 percent below this depth. Reaction is strongly acid to neutral. Base saturation by sum of cations is 35 to 75 percent.

Pedons in which the depth to the 2Bt horizon is greater than 20 inches have a BA horizon. Color is similar to the A horizon color on the mound. Texture, reaction and base saturation are similar to the A horizon. Clay content is 1 to 4 percent higher and increases within a vertical distance of greater than 12 inches.

The Bt horizon is 7.5YR 5/6, 4/6; 5YR 3/3, 3/4, 4/4, 4/6, 5/4, 5/6, 5/8, 6/6; 2.5YR 3/4, 3/6, 4/6, or 5/6. Moist color is 7.5YR 4/6; 5YR 3/4, 4/4, 5/6, 4/6; 2.5YR 3/4, 3/6, 4/6. The lower part of the horizon has hue of 7.5YR in some pedons. Texture is clay loam or clay or their gravelly equivalents with 35 to 55 percent clay in the upper part and clay, sandy clay loam or clay loam or their gravelly equivalents in the lower part. Content of coarse fragments is 5 to 35 percent with 0 to 15 percent cobbles. Increase in clay content at the upper boundary is 15 to 40 percent within 1 inch. Reaction is very strongly acid to slightly acid in the upper part and strongly acid to neutral in the lower part. Base saturation is 75 to 95 percent.

The C horizons are generally stratified. Texture is loamy coarse sand to clay loam or their gravelly or very gravelly equivalents with 10 to 30 percent clay. Content of coarse fragments is 5 to 50 percent with 0 to 15 percent cobbles. Reaction is strongly acid to slightly alkaline. In some pedons this horizon has discontinuous weak cementation.

COMPETING SERIES: These are the [Cometa](#), [Hytop](#), [Millsap](#), [Orognen](#) and [Yokayo](#) series. Cometa soils have greater than 75 percent base saturation in some or all parts of the A horizon. Millsap soils have a lithic contact at 20 to 40 inches. Orognen soils have a soil temperature below 47 degrees from January 1 to February 15 and a frost free season of 190 to 240 days. Yokayo soils have 10YR or 2.5Y hues in the Bt horizon. Hytop soils have a paralithic contact at 20 to 40 inches.

GEOGRAPHIC SETTING: Corning soils are on nearly level to gently rolling high terraces and terrace remnants with mound, intermound microrelief and rolling to hilly sideslopes of terraces. Elevations are 75 to 1,300 feet. Slopes are 0 to 30 percent. The soils formed in gravelly alluvium derived from mixed rock sources. Climate is subhumid with hot dry summers and cool moist winters.

Mean annual precipitation is 14 to 30 inches. Mean annual temperature is about 58 to 62 degrees F, average January temperature is about 45 degrees F and average July temperature is 77 to 82 degrees F. The frost-free period is 185 to 290 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the [Altamont](#) and [Red Bluff](#) soils and the similar [Hillgate](#), [Newville](#), [Redding](#) and [San Ysidro](#) soils. Altamont soils have slickensides and occur on hills underlain by shale. Red Bluff soils have kaolinitic mineralogy.

DRAINAGE AND PERMEABILITY: Well drained on the mound and in areas that lack hummocky microrelief; moderately well drained in the intermound; low to very high runoff on the mound, ponded to slow in the intermound; very slow and slow permeability.

USE AND VEGETATION: Used for annual livestock grazing, dryland grains and irrigated pasture. Vegetation consists of soft chess, wildoats, mouse barley and filaree. Toad rush and bee thistle also occur in the intermound.

DISTRIBUTION AND EXTENT: High terraces in the Sacramento and San Joaquin Valleys in California. The series is of large extent in MLRA- 17. It has been used in the past in MLRA 14 and 15.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Davis, California

SERIES ESTABLISHED: Tehama County (Red Bluff area), California, 1910.

REMARKS: Diagnostic horizons and features recognized in this pedon are:

Ochric epipedon - the zone from the surface to a depth of 21 inches (Ap, A1, A2)

Argillic horizon - the zone from 21 to 36 inches (Bt1, Bt2)

ADDITIONAL DATA: This pedon sampled as S45CA-057-014 in SSIR NO. 24. Other pedons in Sacramento Co. sampled for complete characterization by Lincoln NE NSSL in 1979; pedon numbers are S79CA-067-002 and S79CA-067- 003 for the mound and intermound, respectively. Taxadjunct sampled in Glenn County: NSSL Pedon S45CA-021-012. Also Pedon S45CA-021-013 in Glenn County, CA and S45CA-103-014 in Tehama County.

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